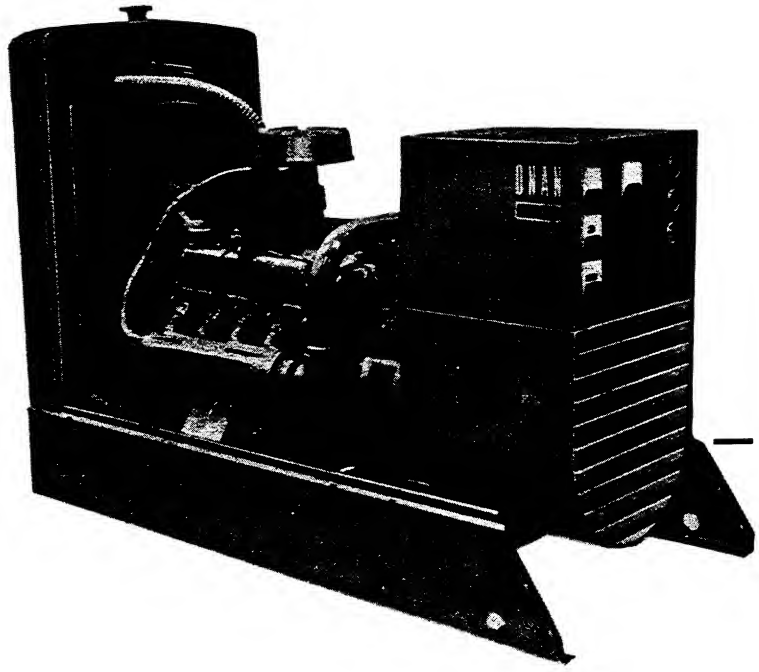
Onan

Operator's Manual

EN, ENT

GenSets



928-0121
10-86
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Safety Precautions

Before operating the generator set, read the Operator's Manual and become familiar with it and the equipment. **Safe and efficient operation can be achieved only if the equipment is properly operated and maintained.** Many accidents are caused by failure to follow fundamental rules and precautions.

The following symbols, found throughout this manual, alert you to potentially dangerous conditions to the operator, service personnel, or the equipment.

⚠DANGER ***This symbol warns of immediate hazards which will result in severe personal injury or death.***

⚠WARNING ***This symbol refers to a hazard or unsafe practice which can result in severe personal injury or death.***

⚠CAUTION ***This symbol refers to a hazard or unsafe practice which can result in personal injury or product or property damage.***

FUEL AND FUMES ARE FLAMMABLE. Fire and explosion can result from improper practices.

- DO NOT fill fuel tanks while engine is running, unless tanks are outside the engine compartment. Fuel contact with hot engine or exhaust is a potential fire hazard.
- DO NOT permit any flame, cigarette, pilot light, spark, or other ignition source near the generator set or fuel tank.
- Fuel lines must be adequately secured and free of leaks. Fuel connection at the engine should be made with an approved flexible line. Do not use copper piping on flexible lines as copper will become brittle if continuously vibrated or repeatedly bent.
- Be sure all fuel supplies have a positive shutoff valve.
- Do not smoke while servicing lead acid batteries. Lead acid batteries emit a highly explosive hydrogen gas that can be ignited by electrical arcing or by smoking.

EXHAUST GASES ARE DEADLY

- Provide an adequate exhaust system to properly expel discharged gases. Visually and audibly inspect the exhaust daily for leaks per the maintenance schedule. Ensure that exhaust manifolds are secure and not warped. Do not use exhaust gases to heat a compartment.
- Be sure the unit is well ventilated.

MOVING PARTS CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

- Keep your hands, clothing, and jewelry away from moving parts.
- Before starting work on the generator set, disconnect starting batteries, negative (-) cable first. This will prevent accidental starting.
- Make sure that fasteners on the generator set are secure. Tighten supports and clamps, keep guards in position over fans, drive belts, etc.
- Do not wear loose clothing or jewelry in the vicinity of moving parts, or while working on electrical equipment. Loose clothing and jewelry can become caught in moving parts. Jewelry can short out electrical contacts and cause shock or burning.
- If adjustment must be made while the unit is running, use extreme caution around hot manifolds, moving parts, etc.

ELECTRICAL SHOCK CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

- Remove electric power before removing protective shields or touching electrical equipment. Use rubber insulative mats placed on dry wood platforms over floors that are metal or concrete when around electrical equipment. Do not wear damp clothing (particularly wet shoes) or allow skin surface to be damp when handling electrical equipment.
- Use extreme caution when working on electrical components. High voltages can cause injury or death. DO NOT tamper with interlocks.
- Follow all applicable state and local electrical codes. Have all electrical installations performed by a qualified licensed electrician. Tag open switches to avoid accidental closure.
- DO NOT CONNECT GENERATOR SET DIRECTLY TO ANY BUILDING ELECTRICAL SYSTEM. Hazardous voltages can flow from the generator set into the utility line. This creates a potential for electrocution or property damage. Connect only through an approved isolation switch or an approved paralleling device.

GENERAL SAFETY PRECAUTIONS

- Coolants under pressure have a higher boiling point than water. DO NOT open a radiator or heat exchanger pressure cap while the engine is running. Allow the generator set to cool and bleed the system pressure first.
- Provide appropriate fire extinguishers and install them in convenient locations. Consult the local fire department for the correct type of extinguisher to use. Do not use foam on electrical fires. Use extinguishers rated ABC by NFPA.
- Make sure that rags are not left on or near the engine.
- Remove all unnecessary grease and oil from the unit. Accumulated grease and oil can cause overheating and engine damage which present a potential fire hazard.
- Keep the generator set and the surrounding area clean and free from obstructions. Remove any debris from the set and keep the floor clean and dry.
- Do not work on this equipment when mentally or physically fatigued, or after consuming any alcohol or drug that makes the operation of equipment unsafe.

Onan

Supplement 928-1007

Date: 10-86
Insert with -
Title: EN Operators Manual (10-86)
Number: 928-0121 (SPEC D)

The following supplemental information is for the new model 75.0 ENT generator set. Index this information in the EN Operators Manual (928-0121).
Use the installation, operation, and maintenance procedures covered in the EN Operators Manual for the ENT generator set **except** where noted in this supplement. The ENT uses the same generator (UR) and control as the EN series generator set and shares many of the same engine components. The engine used in the ENT is basically a turbo-charged, gaseous fueled version of the engine used to power the EN series generator set. A natural gas fuel system is standard, while an LPG fuel system or combination fuel system is available as an option.

Specifications – 75.0 ENT

GENERATOR DETAILS

Type	Revolving Field, 4-Pole, Brushless
Rating (60 Hz Continuous Standby)	75.0 kW (93.75 kVA at 0.8PF)
AC Voltage Regulation	±2%
Phase	3

ENGINE DETAILS

Engine	Ford CSG 875-6005A
Engine Speed	1800 RPM
Fuel (Standard)	Natural Gas
Fuel Inlet Thread Size	
Natural Gas	1 inch NPT Internal
LPG Liquid	1/4 inch NPT Internal
Propane Gas (Optional)	3/4 inch NPT Internal
Exhaust Outlet	
Turbocharger Outlet	2-1/2 inch NPT Internal
Silencer Outlet (Optional)	4 inch NPT External
Starting System Voltage	12
Battery Requirements	
BCI Group	3EE
Capacity	72 Ah (259 kC)
Quantity	1
Cooling System Capacity (Engine and Radiator)	31 Quarts (29 L)
Engine Oil Capacity (Including Filter)	6.5 Quarts (6.2 L)

VOLTAGE OPTIONS

VOLTS	FREQ.	PHASE	AMPERES	REF. VOLTAGE WIRE (W12) TAP
Code 15				
120/240	60 Hz	3	226	H5
120/208	60 Hz	3	261	H3
127/220	60 Hz	3	246	H4
139/240	60 Hz	3	226	H5
240/416	60 Hz	3	130	H3
254/440	60 Hz	3	123	H4
277/480	60 Hz	3	113	H5
Code 9XR				
347/600	60 Hz	3	90	H5 - Not Reconnectible

TUNE-UP SPECIFICATIONS

Use the following specifications even if different from the recommendations in the engine manufacturer's manual.

Spark Plug Type ..... ASF 32M
Spark Plug Torque ..... 10 to 15 Ft-Lbs (14 to 20 N•m)
Spark Plug Gap ..... 0.035 Inch (0.89 mm)
Ignition Point Gap ..... 0.017 Inch (0.43 mm)
Ignition Timing ..... 40° BTC at 1800 RPM
Valve Lash ..... Zero Lash

Description – 75.0 ENT

The ENT generator set is basically an EN series generator set that is modified for turbocharged, gaseous fuel operation. The primary modifications are listed below:

- Turbocharger
- Larger air cleaner
- Air to oil cooler
- Larger capacity radiator
- Modified crankcase ventilation system
- Deeper fan shroud
- Gaseous fuel carburetors only
- Heavy duty distributor
- Modified governor
- High speed water pump
- **Low oil pressure shutdown switch is set at 25 psi.**

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WARNING

TO AVOID POSSIBLE PERSONAL INJURY OR EQUIPMENT DAMAGE, A QUALIFIED ELECTRICIAN OR AN AUTHORIZED SERVICE REPRESENTATIVE MUST PERFORM INSTALLATION AND ALL SERVICE.

INTRODUCTION

FOREWORD

This manual is applicable to the EN Series electric generating sets each consisting of an ONAN UR generator, driven by a Ford LSG 875-6005A Engine. See *SPECIFICATIONS* for generator sizes.

The manual should be used in conjunction with the Ford engine manual, for specific engine information.

WARNING **Onan uses this symbol throughout this manual to warn of possible personal injury.**

CAUTION **This symbol refers to possible equipment damage.**

WARNING

EXHAUST GAS IS DEADLY!

Exhaust gases contain carbon monoxide, an odorless and colorless gas. Carbon monoxide is poisonous and can cause unconsciousness and death. Symptoms of carbon monoxide poisoning can include:

- ***Dizziness***
- ***Nausea***
- ***Headache***
- ***Weakness and Sleepiness***
- ***Throbbing in Temples***
- ***Muscular Twitching***
- ***Vomiting***
- ***Inability to Think Coherently***

IF YOU OR ANYONE ELSE EXPERIENCE ANY OF THESE SYMPTOMS, GET OUT INTO THE FRESH AIR IMMEDIATELY. If symptoms persist, seek medical attention. Shut down the unit and do not operate until it has been inspected and repaired.

Protection against carbon monoxide inhalation includes proper installation and regular, frequent visual and audible inspections of the complete exhaust system.

1-P/EM

SPECIFICATIONS

60 kW

ENGINE DETAILS

Engine Manufacturer	FORD
Engine Series	LSG 875-6005A
Number of Cylinders	V8
Displacement	460 in³ (7.5 litre)
BHP @ 1800 r/min	111.5 (83.18 kW)
Compression Ratio	8.0 to 1
Bore	4.36 inch (110.7 mm)
Stroke	3.85 inch (97.79 mm)
Fuel	Gasoline
Battery Voltage	12V
Battery Group (one 12-Volt, 72 A.H. [259 kC])	3EE
Starting Method	Solenoid Shift
Governor Regulation	5% No Load—Full Load
Battery Charging Current	35 Amperes

GENERATOR DETAILS

Type	UR 15 60 Hz
Rating (Watts)	
60 Hertz Continuous Standby	60,000 (75 kVA)
AC Voltage Regulation	±2%
60 Hertz r/min	1800
Output Rating	0.8 PF
AC Frequency Regulation	3 Hz

CAPACITIES AND REQUIREMENTS

Cooling System, Engine and Radiator	30 quarts (28 litres)
Engine Oil Capacity (Filter, Lines, Crankcase)	6.5 quarts (6.2 L)
Exhaust Connection (inches pipe thread)	3 (Female)

AIR REQUIREMENTS (1800 r/min)

Engine Combustion		190 ft³/min (0.09 m³/s)
Radiator Cooled Engine		8500 ft³/min (4.0 m³/s)
Total for Radiator Cooled Model		8690 ft³/min (4.1 m³/s)
Alternator Cooling Air		1000 ft³/min (0.5 m³/s)
Fuel Consumption at Rated Load		
Regular Gasoline		7.8 gal/hr (8.2 cm³/s)
Natural Gas	1000 BTU/ft³ (37.25 MJ/m³)	888 ft³/hr (0.42 m³/s)
Liquid Petroleum	2500 BTU/ft³ (93.1 MJ/m³)	355 ft³/hr (13.2 m³/s)

GENERAL

Height	52.5 inches (1.33 m)
Width	33.0 inches (0.88 m)
Length	76.31 inches (1.94 m)
Approximate Weight (Mass)	1881 lb (853 kg)

SPECIFICATIONS

70.0 kW

ENGINE DETAILS

Engine Manufacturer	FORD
Engine Series	LSG 875-6005A
Number of Cylinders	V8
Displacement	460 in³ (7.5 litre)
BHP @ 1800 r/min	111.5 (83.18 kW)
Compression Ratio	8.5:1
Bore	4.36 inch (110.744 mm)
Stroke	3.85 inch (97.79 mm)
Fuel	Gasoline
Battery Voltage	12 VDC
Battery Group (one 12-Volt, 72 A.H. [259 kC])	3EE
Starting Method	Solenoid Shift
Governor Regulation	5% No Load—Full Load
Battery Charging Current	35 Amperes

GENERATOR DETAILS

Type	UR 15 60 Hz
Rating (Watts)	
60 Hertz Continuous Standby	70 000 (87.5 kVA)
AC Voltage Regulation	±2%
60 Hertz r/min	1800
Output Rating	0.8 PF
AC Frequency Regulation	3 Hz

CAPACITIES AND REQUIREMENTS

Cooling System, Engine and Radiator	30 quarts (28 litres)
Engine Oil Capacity (Filter, Lines, Crankcase)	6.5 quarts (6.2 L)
Exhaust Connection (inches pipe thread)	3 (Female)

AIR REQUIREMENTS (1800 r/min)

Engine Combustion	190 ft³/min (0.09 m³/s)
Radiator Cooled Engine	8500 ft³/min (4.0 m³/s)
Total for Radiator Cooled Model	8690 ft³/min (4.1 m³/s)
Alternator Cooling Air	1000 ft³/min (0.5 m³/s)
Fuel Consumption at Rated Load (Regular Gasoline)	9.0 gal/hr (9.5 cm³/s)

GENERAL

Height	52.5 inches (1.33 m)
Width	33.0 inches (0.88 m)
Length	76.31 inches (1.94 m)
Approximate Weight (Mass)	1986 lb (901 kg)

TABLE 1.
UR GENERATOR VOLTAGE OPTIONS

55 kW 68.75 kVA 60 Hz

VOLTS	FREQ	PHASE	AMPERES	DOUBLE DELTA	SERIES DELTA	PARALLEL WYE	SERIES WYE	REF. VOLTAGE WIRE (W12) TAP
120/240	60 Hz	1	286*	x				H5
120/240	60 Hz	3	165		x			H5
120/208	60 Hz	3	191			x		H3
127/220	60 Hz	3	180			x		H4
139/240	60 Hz	3	165			x		H5
240/416	60 Hz	3	95				x	H3
254/440	60 Hz	3	90				x	H4
277/480	60 Hz	3	83				x	H5
9XR 347/600	60 Hz	3	66					H3—Not Reconnectible

* This current value is available only from special long stack unit (option B125). A standard 3 phase generator connected into a Double Delta configuration will deliver 2/3 current value shown (286 x .66 = 190 Amperes).

TABLE 1A.
UR GENERATOR VOLTAGE OPTIONS

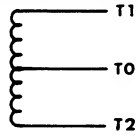
70 kW 87.5 kVA 60 Hz

VOLTS	FREQ	PHASE	AMPERES	DOUBLE DELTA	SERIES DELTA	PARALLEL WYE	SERIES WYE	REF. VOLTAGE WIRE (W12) TAP
120/240	60 Hz	1	365*	x				H5
120/240	60 Hz	3	210		x			H5
120/208	60 Hz	3	243			x		H3
127/220	60 Hz	3	230			x		H4
139/240	60 Hz	3	210			x		H5
240/416	60 Hz	3	121				x	H3
254/440	60 Hz	3	115				x	H4
277/480	60 Hz	3	105				x	H5
9XR 347/600	60 Hz	3	84					H3—Not Reconnectible

* This current value is available only from special long stack unit (option B125). A standard 3 phase generator connected into a Double Delta configuration will deliver 2/3 current value shown (365 x .66 = 242 amperes).

120/240 VOLT, 1 PHASE, 60 HERTZ

NAMEPLATE VOLTAGE CODE 3



CONNECT LEAD FROM TERMINAL 63 TO H5

347/600 VOLT, 3 PHASE, 60 HERTZ

NAMEPLATE VOLTAGE CODE 9X

CONNECT LEAD FROM TERMINAL 63 TO H5

THIS DIAGRAM APPLIES TO 12 LEAD GENERATORS ONLY

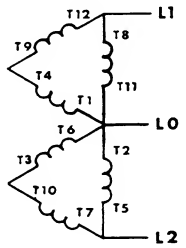
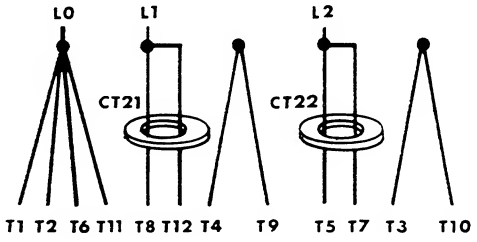
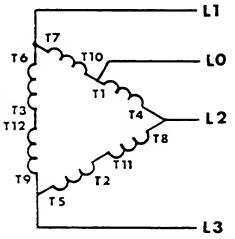
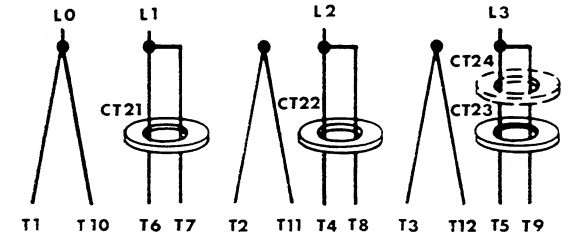
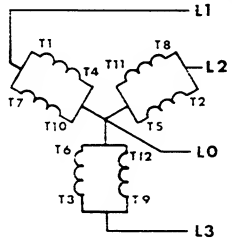
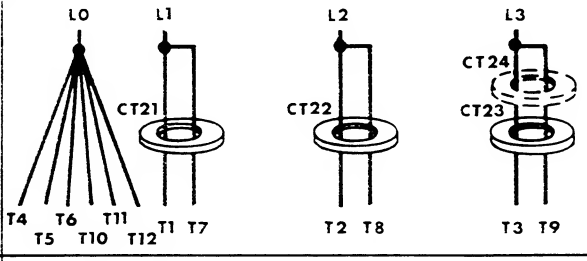
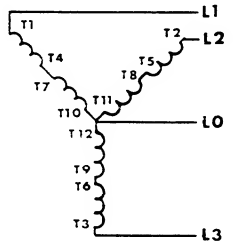
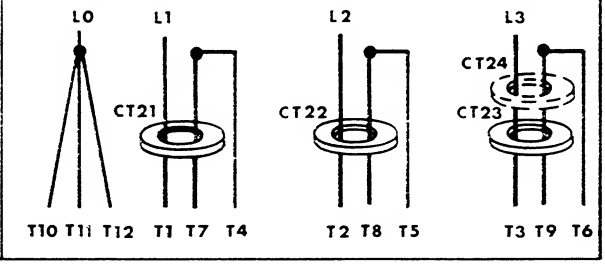
NAMEPLATE VOLTAGE CODE	VOLTAGE	PHASES	HERTZ	CONNECT LEAD FROM TERMINAL 63 TO:	GENERATOR CONNECTION	GENERATOR CONNECTION SCHEMATIC DIAGRAM	GENERATOR CONNECTION WIRING DIAGRAM (WITH CURRENT TRANSFORMERS WHEN USED)
15	120/240	1	60	H5	DOUBLE DELTA		
515	115/230	1	50	H6			
	110/220	1	50	H6			
15	120/240	3	60	H5	SERIES DELTA		
515	115/230	3	50	H6			
	110/220	3	50	H6			
15	120/208	3	60	H3	PARALLEL WYE		
	127/220	3	60	H4			
	139/240	3	60	H5			
515	110/190	3	50	H3			
	115/200	3	50	H4			
	120/208	3	50	H4			
	127/220	3	50	H5			
15	240/416	3	60	H3	SERIES WYE		
	254/440	3	60	H4			
	277/480	3	60	H5			
515	220/380	3	50	H3			
	230/400	3	50	H4			
	240/416	3	50	H4			
	254/440	3	50	H5			

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FIGURE 1. OPTIONAL VOLTAGE CONNECTIONS

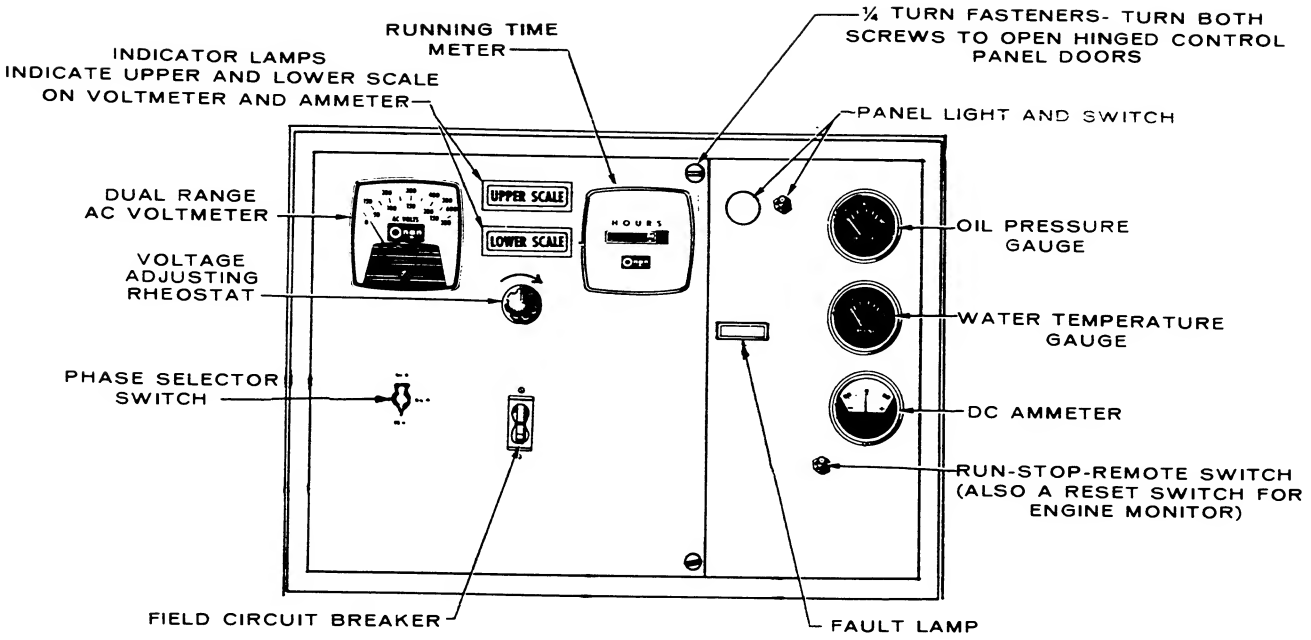


FIGURE 2. STANDARD CONTROL PANEL (ONE FAULT LAMP)

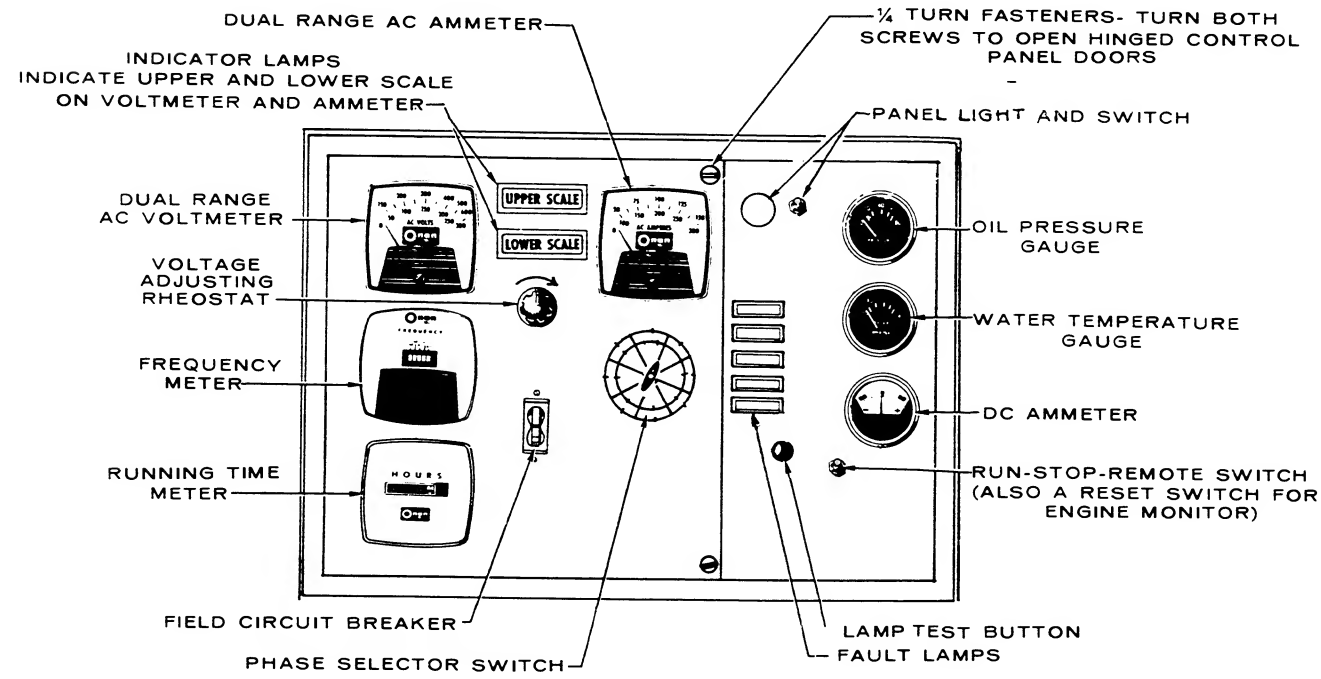


FIGURE 3. OPTIONAL CONTROL PANEL (FIVE FAULT LAMPS)

DESCRIPTION

GENERAL

An Onan EN series electric generating set is a complete unit consisting of an engine driven AC generator, with standard and optional controls and accessories as ordered.

ENGINE

The engine on this unit is a Ford GP-6005A as described in the engine manual. Basic measurements and requirements will be found under *SPECIFICATIONS*. For operation, maintenance and service information, consult the Ford manual.

AC GENERATOR

The generator is an ONAN Type UR, 12 lead, 4 pole revolving field, reconnectible, brushless unit. The main rotor is attached directly to the engine flywheel, therefore engine speed determines generator output frequency. The 60 Hz set operates at 1800 r/min. Excitation is achieved as follows—

Residual alternating voltage from the stator winding is applied to the voltage regulator, where it is compared with a reference voltage, rectified and returned to the field winding of the exciter. Current then induced in the exciter rotor is rectified and fed into the generator rotor. This induces a current in generator stator which is applied to the load.

CONTROL PANEL

The following is a brief description of each of the standard controls and instruments located on the face of the panel. See Figure 2.

DC Panel

Panel Light and Switch: Illuminates control panel.

Oil Pressure Gauge: Indicates pressure of lubricating oil in engine (wired to a sensor unit located on the engine).

Water Temperature Gauge: Indicates temperature of circulating coolant in engine. (Wired to a sensor unit located on the engine.)

Battery Charge Rate DC Ammeter: Indicates battery charging current.

Run-Stop/Reset-Remote Switch: Starts and stops the unit locally or transfers control to a remote location. Resets engine monitor relay in Stop/Reset position.

Warning Light: Indicates "Fault" in engine operation.

AC Panel

AC Voltmeter: Indicates AC generator output voltage. Dual range instrument: measurement range in use shown on indicator light.

Voltage Regulator: Rheostat, provides approximately plus or minus 5 percent adjustment of the rated output voltage.

Exciter Circuit Breaker: Provides generator exciter and regulator protection from overheating, in the event of certain failure modes of the generator, exciter and voltage regulator.

Running Time Meter: Registers the total number of hours, to 1/10th, that the unit has run. Use it to keep a record for periodic servicing. Time is accumulative, meter cannot be reset.

Voltmeter-Ammeter Phase Selector Switch: Selects phases of generator output to be measured by the AC voltmeter and optional AC ammeter

OPTIONAL EQUIPMENT

DC Panel

Warning Lights: Eliminates the one "Fault" light and substitutes five indicator (see Figure 3) lights to give warning of—

a. Overcrank
b. Overspeed
c. Low oil pressure
d. High engine temperature
e. Low engine temperature

Operation of these lights will be discussed in conjunction with engine monitor panel.

Reset Switch: Manual reset for engine monitor after shutdown.

Lamp Test: Press to test warning lamp bulbs (when engine is running only), on five light panels.

AC Panel

AC Ammeter: Indicates AC generator output current. Dual range in use shown on indicator lights.

Frequency Meter: Indicates the frequency of the generator output in hertz. It can be used to check engine speed. (Each hertz equals 30 r/min.)

CONTROL PANEL INTERIOR

The only equipment discussed in this section will be that which the operator may have reason to adjust or inspect for service.

Terminal Board (TB) 21

Connection of wire W12 to terminals H3, H4, H5, and H6 is made at this point, to change reference voltage when reconnecting generator for different voltages. Refer to Figure 1.

Voltage Regulator

Solid state unit, consisting of printed circuit board VR21; an SCR bridge CR21, with a commutating reactor L21 are located in the control panel as part of the voltage regulator system. AC output from generator is controlled at predetermined level regardless of load; regulation is plus or minus 2 percent from no load to full load, at 0.8 PF.

Engine Monitor

Printed circuit plug-in modules provide the following functions:

1. A 75 second cranking period.
2. Approximately a 12.5-second time delay for oil pressure buildup.
3. An external alarm contact to light a fault lamp and shut down the set for alarm conditions such as:
   a. Overcrank (failed to start after cranking 75 seconds).
   b. Overspeed (engine speed reaches 2100 r/min). See Figure 4.
   c. Low oil pressure 14 psi (96.5 kPa).
   d. High engine temperature 215° F (102° C).

CAUTION **High Engine Temperature Cutoff will shut down engine in an overheat condition only if coolant level is sufficiently high to physically contact shutdown switch. Loss of coolant will allow engine to overheat without protection of shutdown device, thereby causing severe damage to the engine. It is therefore imperative that adequate engine coolant levels be maintained, to ensure operational integrity of cooling system and engine coolant overheat shutdown protection.**

On standard control panels, all four alarms are wired into one common fault lamp; on units with five fault lamps, four have shutdown alarms, the fifth (low engine temperature) lights a fault lamp only. Refer to Table 2.

Standard Cranking Module

Limits engine cranking time to 75 seconds. If engine fails to start after 75 seconds the engine monitor lights a fault lamp and opens the cranking circuit.

OPTIONAL MODULES

Cycle Cranker

Plug-in module replaces standard cranking circuit. Automatically provides a 15 second crank time and a 10 second rest time for three ON and two OFF cycles in 65 seconds. If engine fails to start, after 75 seconds the engine monitor lights a fault lamp and opens the cranking circuit. The ON and OFF cycle times are nominal and can be adjusted at potentiometers on the cranker module board.

Pre-Alarm

Gives advance warning for low oil pressure or high engine temperature. Requires two sensors each for engine temperature and oil pressure.

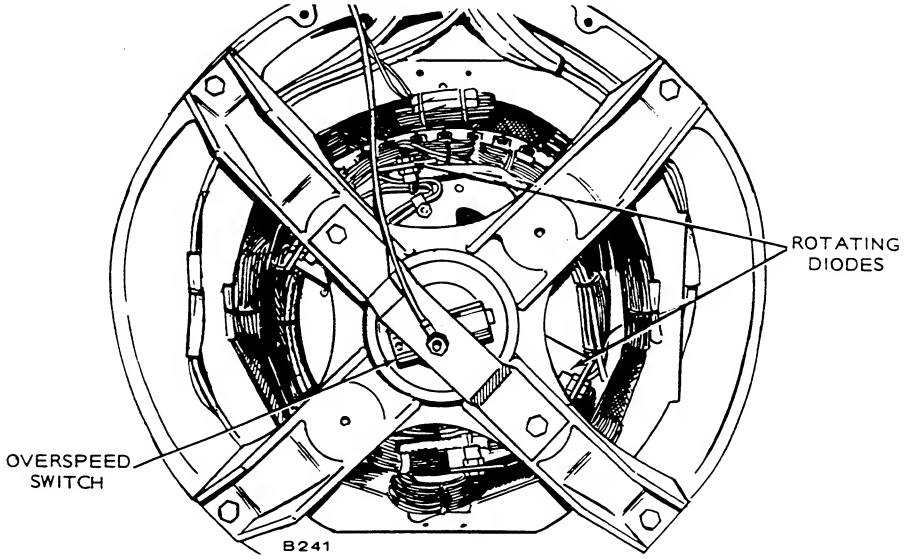


FIGURE 4. OVERSPEED SWITCH

TABLE 2. FAULT LAMP OPTIONS

SYSTEM	FAULT	FAULT LAMP	STOP ENGINE	EXTERNAL ALARM	PRE-ALARM
PENN STATE SINGLE LIGHT	Overcrank	x	x	x	
	Overspeed	x	x	x	
	Low Oil Pressure	x		x	
	High Engine Temperature	x		x	
STANDARD SINGLE LIGHT	Overcrank	x	x	x	
	Overspeed	x	x	x	
	Low Oil Pressure	x	x	x	
	High Engine Temperature	x	x	x	
5 LIGHT	Overcrank	x	x	x	
	Overspeed	x	x	x	
	Low Oil Pressure	x	x	x	
	High Engine Temperature	x	x	x	
	Low Engine Temperature	x			
5 LIGHT PRE-ALARM	Overcrank	x	x	x	
	Overspeed	x	x	x	
	Low Oil Pressure	x	*	x	x
	High Engine Temperature	x	*	x	x
	Low Engine Temperature	x			

* - With additional optional sensors.

ENGINE SENSORS

Resistance units and switches in the engine temperature and oil pressure monitoring and shutdown systems are sealed units and are not repairable.

For location, refer to Figures 5 and 6. When changing a sensor, do not substitute, use recommended replacement parts. Resistance units are matched to the gauge they supply, and cut-off switches are close-tolerance actuation parts, made for a specific application.

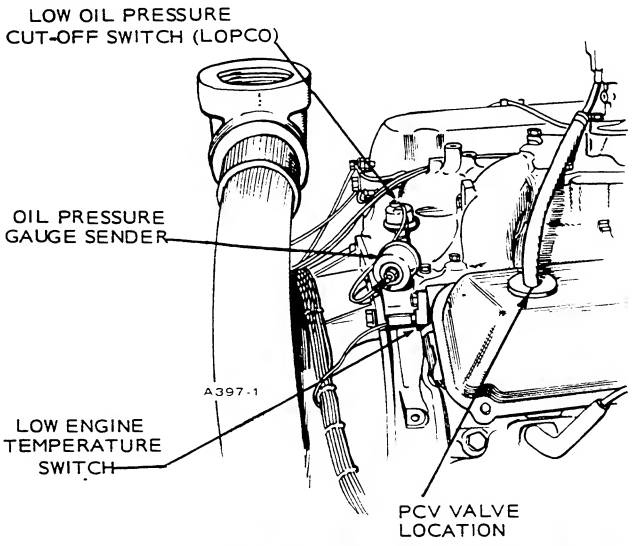
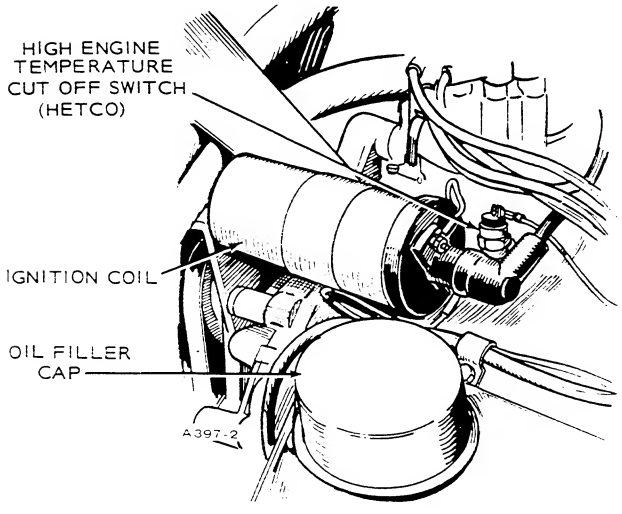


FIGURE 6. OIL PRESSURE MONITORS



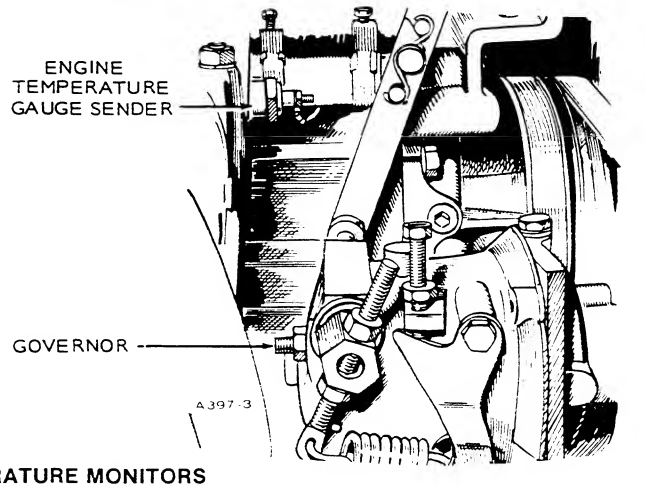


FIGURE 5. WATER TEMPERATURE MONITORS

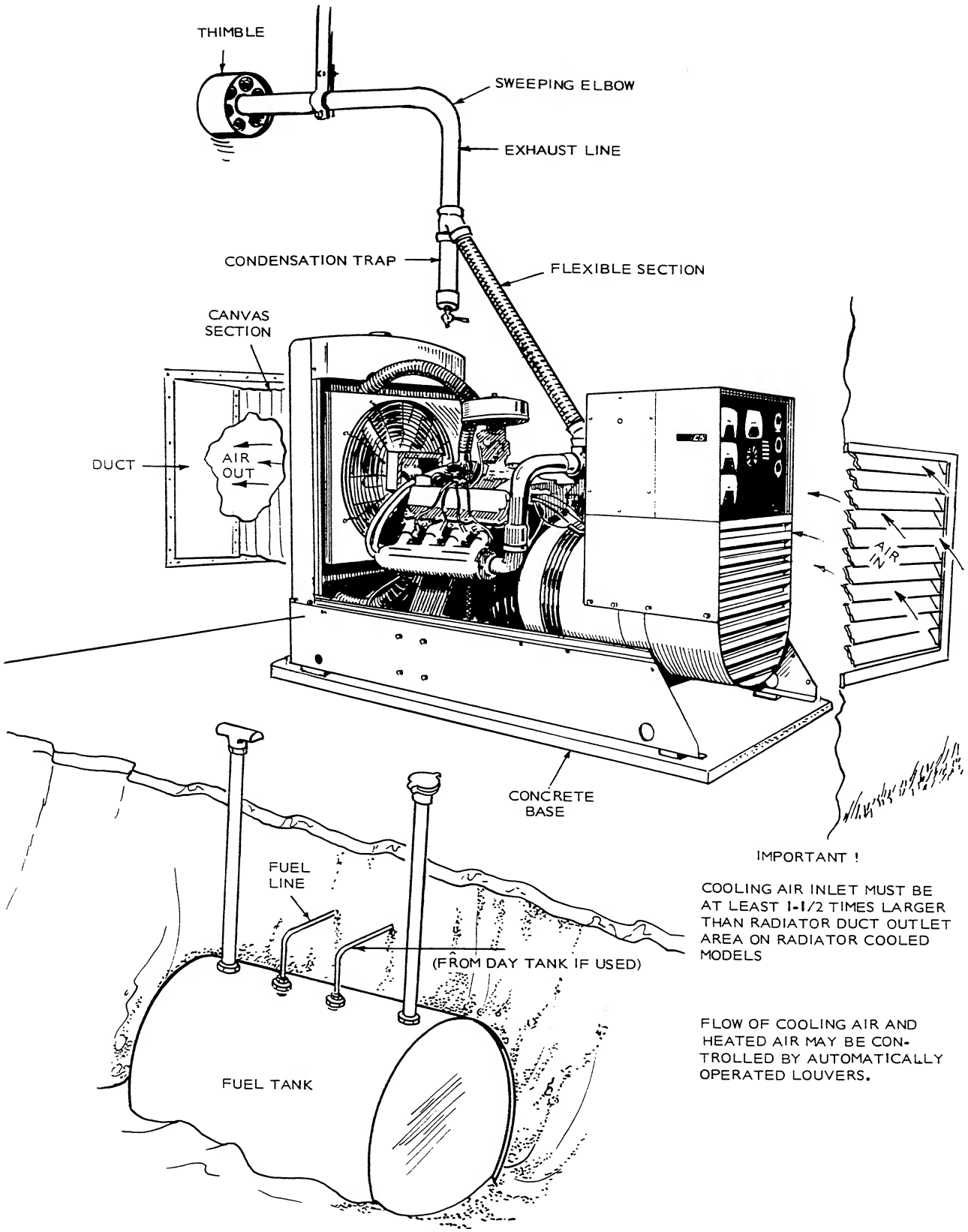


FIGURE 7. TYPICAL EN INSTALLATION

INSTALLATION

GENERAL

Installations must be considered individually. Use these instructions as a general guide. All installations must meet regulations of state and local building codes, fire ordinances, etc., which may affect installation details (see Figure 7). Refer to *ONAN Technical Bulletin T-030* for further installation information.

Requirements to be considered prior to installation:

1. Level mounting surface.
2. Adequate cooling air.
3. Adequate fresh induction air.
4. Discharge of circulated air.
5. Discharge of exhaust gases.
6. Electrical connections.
7. Fuel installation.
8. Water supply (city water cooling).
9. Accessibility for operation and servicing.
10. Vibration isolation.
11. Noise levels.

LOCATION

Provide a location that is protected from the weather and is dry, clean, dust free and well ventilated. If practical, install inside a heated building for protection from extreme weather conditions.

MOUNTING

Generator sets are mounted on a rigid skid base which provides proper support. The engine-generator assembly is isolated from the skid base by rubber mounts which provide adequate vibration isolation for normal installations. For installations where vibration control is critical, install additional spring-type isolators between skid base and foundation.

For convenience in general servicing and changing crankcase oil, mount set on raised pedestal at least 6 inches (150 mm) high.

VENTILATION

Generator sets create considerable heat which must be removed by proper ventilation. Outdoor installations rely on natural air circulation but indoor installations need properly sized and positioned vents for the required air flow. See *SPECIFICATIONS* for the air required to operate with rated load under normal conditions at 1800 r/min.

Radiator set cooling air travels from the rear of the set and is removed by a pusher fan which blows out through the radiator. Locate the air inlet to the rear of the set.

Locate the cooling air outlet directly in front of the radiator and as close as possible. The opening free area must be at least as large as the radiator area. Length and shape of the air outlet duct should offer minimum restriction to air flow. Use a duct of canvas or sheet metal between the radiator and the air outlet opening. The duct prevents recirculation of heated air.

For operation outside a building, a shelter housing with electrically operated louvres is available as an option. Transformers connected across the generator output supply current to the motors.

When the generator is operating, current in the transformers actuate the motors and open the louvres. The louvres are held open for the duration of the set operation, then are closed by return springs when the set is shut down.

City water cooled sets do not use the conventional radiator. A constantly changing water flow cools the engine. Sufficient air movement and fresh air must be available to properly cool the generator, disperse heat convected off the engine and support combustion in the engine.

Installations require an auxiliary fan (connected to operate only when the unit is running) of sufficient size to assure proper air circulation and evacuation of fumes.

COOLING SYSTEM

Standard Radiator Cooling, uses a set mounted radiator and engine driven pusher type fan to cool engine water jacket. Air travels from the generator end of the set, across the engine and out through the radiator. An integral discharge duct adapter flange surrounds the radiator grille.

Heat Exchanger Cooling (optional), uses a shell and tube type heat exchanger instead of the standard radiator and fan. Engine jacket coolant circulates through the shell side of the heat exchanger, while raw cooling water is pumped through the tubes. Engine coolant and raw water do not mix. This type of cooling separation is necessary when the raw water contains scale forming lime, or other impurities.

This system reduces set enclosure airflow requirements and noise levels. Proper operation depends upon a constant supply of raw water for heat removal. The engine coolant side of the system may be protected from freezing; the raw water side cannot. See Figure 8 for typical installation.

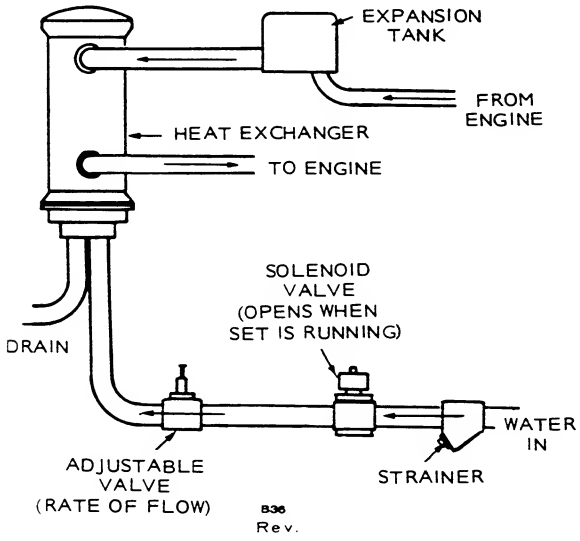


FIGURE 8. TYPICAL HEAT EXCHANGER SYSTEM

Standpipe Cooling (optional) substitutes a mixing (tempering) tank for the standard radiator and fan. Cooling water circulating through the engine jacket is mixed with raw water in the tank. Because raw water flows through the engine jacket, it must not contain scale forming impurities or fouling of the engine water passages will occur. Fouling results in engine overheating and costly repair bills.

This system reduces set enclosure airflow requirements and noise levels. Proper operation is dependent on a constant supply of cooling water. The system cannot be protected from freezing. See Figure 9.

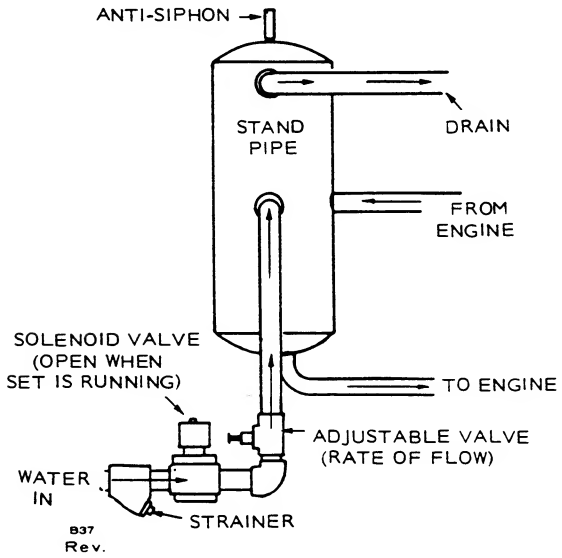


FIGURE 9. TYPICAL STANDPIPE SYSTEM

Remote Radiator Cooling (optional), substitutes a remote mounted radiator and an electrically driven fan, for the set mounted components. Removal of the radiator and fan from the set reduces set enclosure airflow requirements and noise levels without forcing dependence on a continuous cooling water supply. The remote radiator system can be completely protected against freezing.

This system must be designed to meet specific requirements of the application.

Water Jacket Heater (optional) may be installed to keep engine coolant warm while engine is shut down. It heats and circulates the coolant within the engine, which reduces start-up time and engine wear caused by cold starts. It is electrically operated and thermostatically controlled.

Direct Flow Installation

With this system, a city or raw water cooling supply under pressure forces water directly into the engine, through the engine and to the outlet. An adjustable valve controls the incoming water flow rate to obtain correct engine water temperature, as measured at engine coolant water outlet while the generator set is operating under full load. A solenoid valve is coordinated with the generator set system to open during set operation.

CAUTION **Restrict inlet water pressure to a maximum of 7 psi or 48.3 kPa, otherwise engine gaskets and seals will leak.**

Raw water cooling is often undesirable because:

1. The water supply must be very clean or engine deposits will result.
2. A high temperature differential between the cold incoming water into the engine and warm discharged water can put damaging stresses on engine components (no overall uniform engine temperature).

Water Cooled Manifolds

CAUTION **Severe damage will occur to water cooled manifolds if size or routing of water pipe is deviated from that of factory installation. This has been designed to allow maximum cooling of manifolds (see Figure 10).**

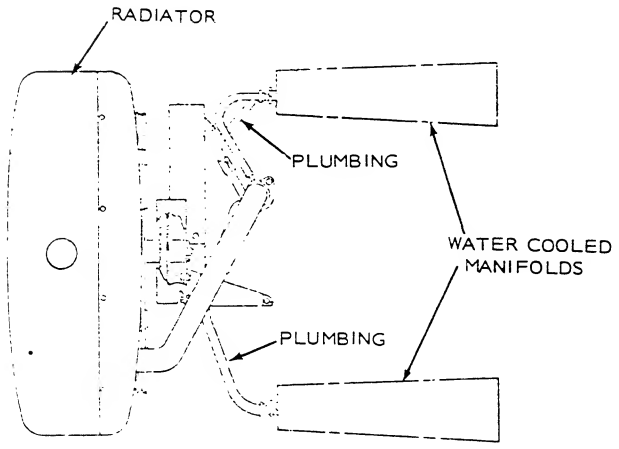


FIGURE 10. WATER COOLED MANIFOLDS

COOLING CONNECTIONS

The radiator cooled (standard) set does not require any external connections except as discussed under *Ventilation*. Allow clearance around the set for access to service the radiator and fan belts. See Figure 7.

Heat Exchanger and Standpipe cooled sets must be connected to a pressurized supply of cold water. Make connections to the set with flexible pipe to absorb vibration. On the cool water line install a solenoid valve to shut off the flow when the set is shut down and a rate of flow valve to control engine temperature. This valve can be either manual or automatic. Actual rate of flow will depend on inlet water temperature and applied load.

Adjust the flow to maintain water temperature between 165° F and 195° F (73.9° C and 90.6° C) while viewing the water temperature gauge.

Before filling cooling system check all hardware for security. This includes hose clamps, capscrews, fittings and connections. Use flexible coolant lines with heat exchanger, standpipe or remote mounting radiator.

Remote radiator plumbing will vary with installation. All systems must comply with the following conditions—

1. Make all connections to the set and to the radiator with flexible pipe.
2. Install an auxiliary circulating pump if the horizontal distance between the engine and pump exceeds 15 feet (4.65 m).
3. Install a hot-well system to relieve excess engine water jacket pressure if the top of the radiator is more than 15 feet (4.65 m) above the center-line of the engine crankshaft.

EXHAUST

WARNING **Inhalation of exhaust gases can result in death.**

Engine exhaust gas must be piped outside building or enclosure. Do not terminate exhaust pipe near inlet vents or combustible materials. An approved thimble (Figure 11) must be used where exhaust pipes pass through walls or partitions. Pitch exhaust pipes downward or install a condensation trap (Figure 12) at the point where a rise in the exhaust system begins. Avoid sharp bends; use sweeping long radius elbows. Provide adequate support for mufflers and exhaust pipes. Refer to Figure 7 for a typical exhaust installation. Shield or insulate exhaust lines if there is danger of personal contact. Allow at least 9 inches (230 mm) of clearance if the pipes run close to a combustible wall or partition. Use a pipe at least as large as the 3 inch (76.2 mm) pipe size outlet of the engine.

Suspend the pipe from the enclosure structure and attach to engine with a flexible section. Place muffler as close to engine as possible to reduce condensation damage and carbon fouling.

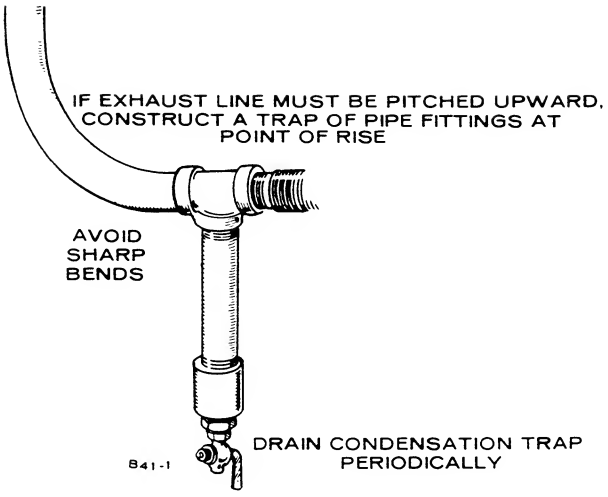


FIGURE 12. EXHAUST CONDENSATION TRAP

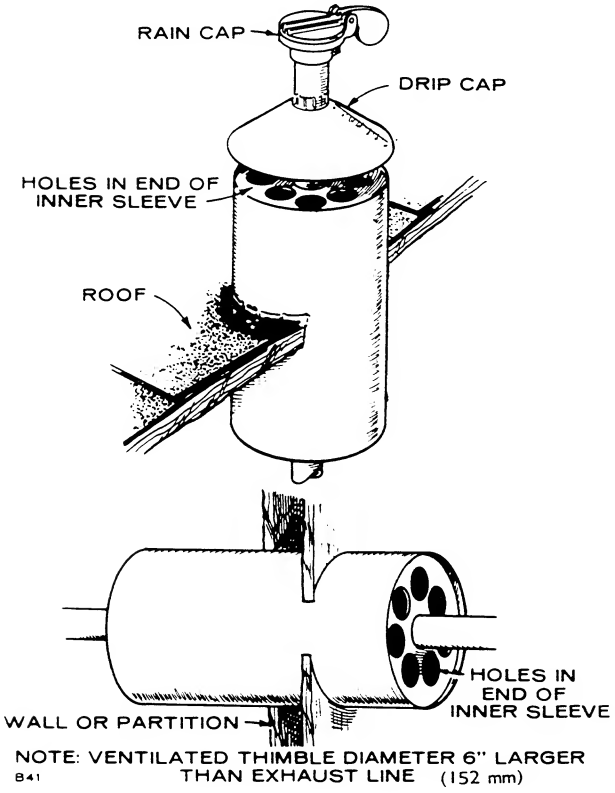


FIGURE 11. TYPICAL EXHAUST THIMBLE

A critical muffler recommended for this unit is sized for a 3½-inch (89 mm) exhaust pipe. Maximum allowable length of pipe for this diameter is 145 feet (44 m).

Maximum permissible exhaust restriction (back pressure) is 1.5 inches (38.0 mm) Hg.

FUEL SYSTEM

Ford engines used on EN sets are designed to operate on gasoline with an average regular grade of 90 octane.

FUEL CONNECTIONS

Before starting any type of fuel installation, ONAN recommends that the regulations described in Pamphlet 58 of the National Fire Prevention Association (NFPA) be studied. All pertinent state and local codes, most of which are governed by NFPA 58, must be complied with, and the installation must be inspected before the unit is put in service.

Fuels under pressure (e.g. natural gas or LPG) must be controlled by a positive shut off valve, preferably automatic, in addition to any valve integral with the carburetor or gas regulator equipment.

Connection of gasoline fuel inlet line requires a 1/8-inch pipe fitting to an adapter on skid base.

Lift to fuel pump should not exceed 6 feet (2 m), horizontal distance between set and fuel tank should not exceed 50 feet (15 m). Use 3/8-inch tubing up to 25 feet (12.5 m), 1/2-inch up to 50 feet (15 m).

Optional Day Tank

The engine may be equipped with a one quart reservoir tank to replenish fuel lost from the carburetor by evaporation during shutdown. See Figure 13. Connect a 5/16-inch return line between the reservoir upper side fitting (this fitting has a restricted orifice and must be used) and the main supply tank. Be sure the return line has a continuous drop to the main supply tank with no dip-and-rise where fuel could collect and form a vent seal. See that the top center opening of the tank is tightly plugged.

Natural or Manufactured Gas

On sets equipped with an Impco carburetor, gas pressure at the carburetor must be set at 3-ounces (1.3 kPa) gauge, or 5-inch (127 mm) water column, manometer, with the engine running at 1800 r/min on no load.

Thermac regulator is designed for a maximum line pressure of 6 ounces (2.6 kPa) gauge, or 10.38-inches (263.6 mm) water column, manometer.

If line pressure is excessive, install a suitable pressure reducing regulator. Be sure to comply with all local regulations such as:

- Recommended electric shutoff valve.
- Hand shutoff valve at the fuel source.
- Supply line filter.

Use a short length of approved flexible connection between the supply pipe and the set regulator inlet.

Combination Gas-Gasoline

Combination gas-gasoline sets are designed for normal operation on gas fuel, with provision for emergency operation on gasoline. Both gas and gasoline procedures must be followed. A reservoir tank is sometimes provided, so a fuel return line may be necessary as described for gasoline fuel.

BATTERY

Starting the unit requires 12 volt battery current. Use one 12 volt (see specification) battery for a normal installation. Connect the battery as in Figure 14.

Connect battery positive before connecting battery negative, to prevent the possibility of arcing.

Necessary battery cables are on unit. Service battery as necessary. Infrequent set use (as in emergency standby service) may allow battery to self-discharge to the point where it cannot start the unit. If installing an automatic transfer switch that has no built-in charge circuit, connect a separate trickle charger. Onan automatic transfer switches include such a battery charging circuit.

WARNING **Do not smoke while servicing batteries. Lead acid batteries give off explosive gases while being charged.**

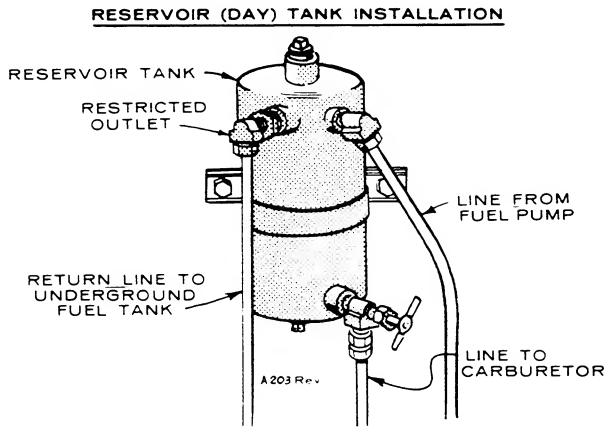


FIGURE 13. DAY TANK INSTALLATION

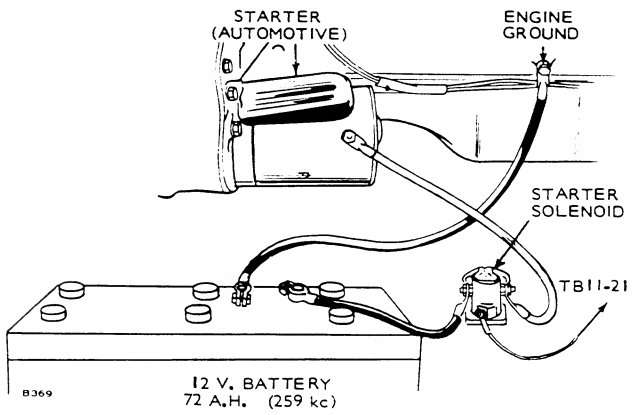


FIGURE 14. BATTERY CONNECTION

REMOTE CONTROL CONNECTIONS

Provision is made for addition of remote starting. This is accomplished on a 4 place terminal block situated within the control box. Connect one or more remote switches across remote terminal and B+ terminal as shown in Figure 15. If the distance between the set and remote station is less than 1000 feet (305 m), use No. 18 AWG wire; between 1000 and 2000 feet (305 m and 610 m), use No. 16 AWG wire.

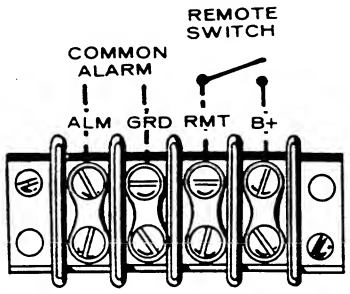


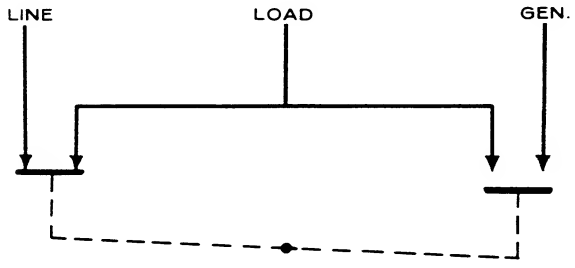
FIGURE 15. REMOTE START CONNECTION (TB12)

WIRING CONNECTIONS

Most local regulations require that wiring connections be made by a licensed electrician and that the installation be inspected and approved before operation. All connections, wire sizes, etc. must conform to requirements of electrical codes in effect at the installation site.

Generator set grounding must be in accordance with National Electrical Code (NFPA 70-1978) Article 250.

If the installation is for standby service, a double throw transfer switch must always be used. Connect this switch (either automatic or manual) so that it is impossible for commercial power and generator current to be connected to the load at the same time. See Figure 16. Instructions for connecting an automatic load transfer control are included with such equipment.



NOTE: SHOWN WITH LINE CONNECTED TO LOAD.

FIGURE 16. LOAD TRANSFER SWITCH (TYPICAL FUNCTION)

Control Box Connections

The factory ships these 12 lead generators with load connection wires NOT connected together in the control box. These 12 wires are labeled T1 through T12 and must be brought together before making load connections. Proceed as follows:

1. Remove either right, left or top panel from control box. See Figure 17.
2. Connect wires together as shown on panel drawing and in Figure 1 according to voltage desired.
3. Identify leads connected together, appropriately as L0, L1, L2 or L3 before making load connections.
4. Open hinged control panel doors. Connect lead from terminal 63 to correct terminal for voltage desired. These terminals are labeled H2, H3, H4, H5 and H6. See Figures 1 and 18.

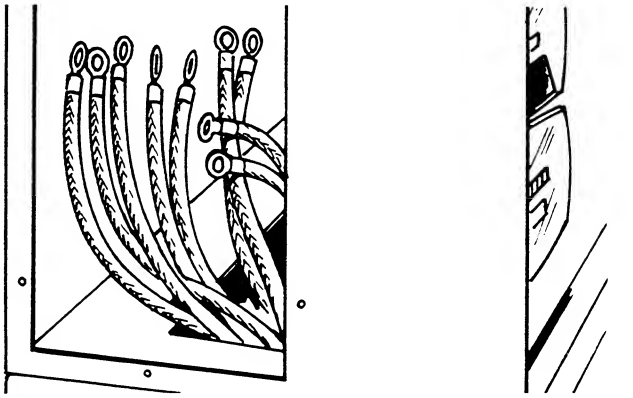


FIGURE 17. CONTROL BOX (SIDE PANEL REMOVED)

5. Close front panel and secure with 1/4 turn fasteners.
6. Connect load wires to generator leads through current transformers (see Figure 1).
7. Insulate connections as needed.

Preceding instructions do not apply to models designated Code 9X; this connection is made at the factory. The installer must only connect load wires.

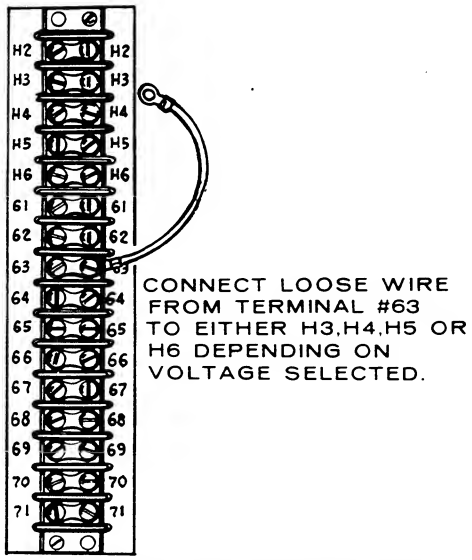


FIGURE 18. REFERENCE VOLTAGE CONNECTION (TB21)

120/240 Volt, Single Phase, 12 Lead: Terminal connection L0 can be grounded (neutral). For 120 volts, connect the hot load wires to either the L1 or L2 connection, Figure 19. Connect the neutral load wire to the grounded L0 connection. Two 120 volt circuits are thus available, with not more than 1/3 the rated capacity of the set available on either circuit. If using both circuits, be sure to balance the load between them.

For 240 volts, connect one load wire to the L1 connection and the second load wire to the L2 connection. Terminal connection L0 is not used for 240 volt service.

Only 2/3 of rated current is available from this connection.

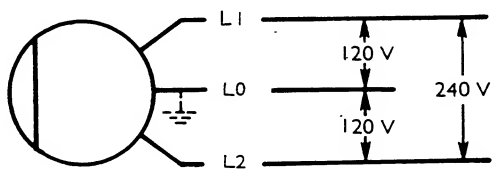


FIGURE 19. 120/240 V. 1 PHASE DOUBLE DELTA

120/240 Volt, 3 Phase, Delta Connected Set; 12 Lead: The 3 phase Delta connected set is designed to supply 120 and 240 volt, 1 phase current and 240 volt, 3 phase current, Figure 20. For 3 phase operation, connect the three load wires to generator terminals L1, L2 and L3—one wire to each terminal. For 3 phase operation the L0 terminal is not used.

For 120/240 volt, 1 phase, 3 wire operation, terminals L1 and L2 are the "hot" terminals. The L0 terminal is the neutral, which can be grounded if required. For 120 volt service, connect the black load wire to either the L1 or L2 terminal. Connect the neutral (white) wire to the L0 terminal. Two 120 volt circuits are available. Connect between any two 3-phase terminals for 240 volt 1 phase loads.

Any combination of 1 phase and 3 phase loading can be used at the same time as long as total current does not exceed the NAMEPLATE rating of the generator. If no 3 phase output is used, usable 1 phase output is 2/3 of 3 phase kVA.

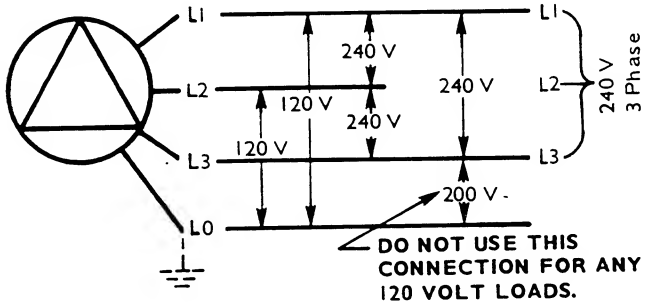


FIGURE 20. 120/240 V. 3 PHASE DELTA

3 Phase, Wye Connected Set: The 3 phase, 12 wire set produces line to neutral voltage and line to line voltage. Line to neutral voltage is the lower voltage as noted on the unit nameplate, line to line voltage is the higher nameplate voltage.

For 3 phase loads, connect separate load wires to each of the set terminals L1, L2 and L3. Single phase output of the higher nameplate voltage is obtained between any two 3 phase terminals as shown in Figure 21.

The terminal marked L0 can be grounded. For 1 phase loads, connect the neutral (white) load wire to the L0 terminal. Connect the black load wire to any one of the other three terminals—L1, L2, or L3. Three separate 1 phase circuits are available, with not more than 1/6 the rated capacity of the set from any one circuit.

If using 1 phase and 3 phase current at the same time, use care to properly balance the 1 phase load, and not to exceed rated line current.

Figure 21 shows load connections for 120/208 voltage. Other voltages are available from either parallel wye or series wye illustration in Figure 1.

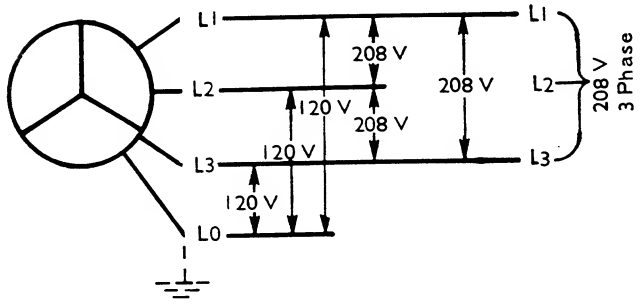


FIGURE 21. 120/208 V. 3-PHASE WYE

GROUNDING

Typical requirements for bonding and grounding are given in the National Electrical Code, 1978, Article 250.

Periodic inspection is recommended, especially after service work has been performed on equipment anywhere in the electrical system.

Generator Set Bonding and Equipment Grounding

Bonding is defined as: (Reference National Electrical Code, 1978, Article 100) The permanent joining of metallic parts to form an electrically conductive path which will assure electrical continuity and capacity to conduct safely any current likely to be imposed.

WARNING **It is extremely important for life safety that bonding and equipment grounding be properly done, and that all metallic parts likely to become energized under abnormal conditions be properly grounded.**

Circuit and System Grounding

This refers to the intentional grounding of a circuit conductor or conductors. The design and installation of grounding system incompasses many considerations, such as multiple transformers, standby generators, ground fault protection, physical locations of equipment and conductors, just to mention a few.

Although the consulting engineer and installer are responsible for the design and wiring of each particular grounding application, the basic grounding requirements must conform to national and local codes.

OPERATION

GENERAL

ONAN EN Series electric generating sets are given a complete running test under various load conditions and are thoroughly checked before leaving the factory. Inspect your unit closely for loose or missing parts and damage which may have occurred in transit. Tighten loose parts, replace missing parts and repair any damage before putting set into operation.

PRESTART SERVICING

Lubrication System

Engine oil was drained prior to shipment. Fill engine to capacities shown. After engine has been run, check dipstick, add oil to bring level to safe mark (see Figure 22). Record total capacity for future oil changes. Do not mix brands nor grades of lubricating oils.

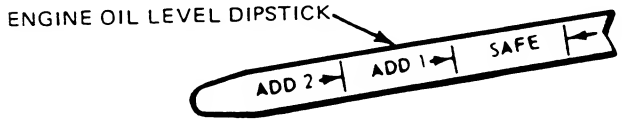


FIGURE 22. OIL LEVEL DIPSTICK

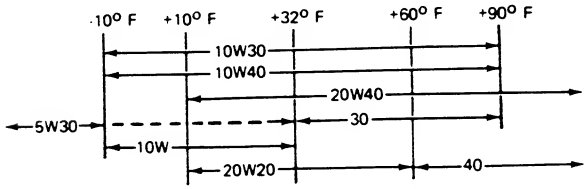


FIGURE 23. OIL VISCOSITIES

Oil capacities (nominal)

Oil Pan and Filter — 5 quarts (4.7 litres)

Cooling System

Cooling system was drained prior to shipment. Fill cooling system before starting. Nominal capacity is 30-quarts (28 litres). For units using either a radiator or heat exchanger (city water cooled), fill the system with clean soft water, and a permanent anti-freeze equal to 0°F (-17°C) protection, to guard against corrosion and coolant boiling. If a possibility exists of a radiator cooled set being exposed to freezing temperatures use anti-freeze with an ethylene-glycol base. During initial engine run, check the coolant level several times and replenish if necessary to compensate for air pockets which may have formed during filling. Refer to Ford engine manual for additional information.

CAUTION **1. Verify that the electric solenoid valve used with city water cooled sets is open before initial starting of set to allow coolant chambers to fill. Overheating and damage to the engine could result from non-compliance.**

2. If engine is equipped with a cooling system filter, do not use antifreeze with an anti-leak formula. The stop leak element can prevent or retard the coolant flow through the filter, thereby eliminating the filtering process completely.

WARNING **Be careful when checking coolant under pressure. It is advisable to shut engine down and bleed off pressure before removing pressure cap. Severe burns could result from contact with hot coolant.**

Fuel

If the set uses gasoline fuel, see that the fuel supply tank is properly filled with automotive "regular" gasoline. Do not use highly leaded premium grade gasoline. Check with the fuel supplier for assurance that the fuel supplied meets the specifications. Make every effort to keep the fuel supply clean.

If the set is equipped for gas fuel, see that the fuel supply is turned on. Observe all safety precautions regarding the use of gas fuel.

Combination Gas-Gasoline

A set designed for normal operation on gas fuel with the provision for emergency operation on gasoline requires adjustments to be made by the operator prior to operation.

The set is equipped with a carburetor mounted gas-gasoline toggle switch. The switch is provided by Onan to enable the operator to switch fuel stop valves for gas and gasoline in or out of the generating set control circuitry. The fuel stop valves are *not* provided by Onan.

For operation on gaseous fuel insure that the gasoline manual shutoff valve is shut. Adjust the electric choke so the cover is turned 10 to 12 notches counterclockwise from the "*" mark. The solenoid valve in the main jet of the gasoline carburetor must have its power lead disconnected to prevent gasoline from entering the intake manifold when the engine is started. Insure that the lead is clear of the carburetor and governor throttle linkage. Position the fuel select toggle switch to the appropriate position.

For operation on gasoline adjust the choke so the cover is turned to the "*" mark, connect the main jet solenoid valve power lead, open the gasoline manual shutoff valve, and position the toggle switch to the gasoline position.

Check all connections in fuel system for security, to ensure that pressure will not bleed off when engine is not in use. Pressure should be maintained for immediate starting if unit is on standby service.

BATTERIES

Ensure that the cable connections to the batteries are secure. Coat connections with non-conductive grease to retard formation of corrosive deposits.

Check level of electrolyte to be at split ring mark. Measure specific gravity of electrolyte: SG 1.260 at 80° F (26.7° C). If distilled water has been added or specific gravity is less than 1.260, place batteries on charge until desired reading is reached. Do not over charge.

STARTING

When the preceding service functions have been performed, recheck to verify unit is ready to start.

1. Crankcase filled.
2. Cooling system filled.
3. Batteries charged and connected.
4. Fuel solenoid valve open.

To start, move the "run-stop/reset-remote" switch to the "run" position. The engine should start after a few seconds of cranking. Immediately after start, observe the oil pressure gauge. Normal oil pressure is between 30 and 55 psi (207 and 380 kPa). Check the following gauges:

1. DC Ammeter—10 to 30 amperes.
2. AC Voltmeter—AC generator output voltage.
3. Frequency Meter — AC generator output frequency.

After running 10 minutes under load the water temperature gauge should have stabilized at 180° to 195° F (82° to 90° C). On city water cooled units an adjustable valve is connected in the water supply line. Adjust the hand wheel valve to provide a water flow that will keep the water temperature gauge reading within the range of 165° F to 195° F (74° C to 90° C).

Break-In Note

Run set at 50 percent load for the first half-hour of initial operation after reaching operating temperature.

Non-Start

If after a few seconds of cranking, engine fails to start. or starts and runs then stops and fault lamp lights, refer to appropriate troubleshooting chart, Table 3 or Table 4.

If a restart attempt is made within two minutes of shutdown, engine will crank approximately 15 seconds before start.

STOPPING

To reduce and stabilize engine temperatures, run the engine at no load for three to five minutes before shutting down.

Move the run-stop/reset-remote switch to stop position to shut down the set.

EXERCISE PERIOD

Generator sets on continuous standby service are required to be operative at essential loads from a cold start in a short period of time in the event of a power outage.

This imposes severe conditions on the engine. Friction of dry piston rings upon dry cylinder walls causes scuffing and rapid wearing. These can be relieved by exercising the set at least once a week for a minimum time of 30 minutes per exercise period. Preferably, run the set under at least 50 percent load to allow the engine to reach normal operating temperature. This will keep engine parts lubricated, maintain fuel prime, prevent electrical relay contacts from oxidizing and insure easy emergency starts. ONAN automatic transfer switches contain an optional exercise switch which, by pre-selection, will start, determine run period and shut down a set on a weekly frequency. For example, the switch can be set for time of start, length of run, A.M. or P.M. and day of week.

After each exercise period, top up fuel tank, check engine for leaks and unit for general condition. Locate cause of leaks (if any) and correct.

HIGH ALTITUDE

Ratings apply to altitudes up to 1000 feet (304 m) standard cooling, normal ambients and specified fuels. Consult factory or nearest authorized Onan distributor for operating characteristics under other conditions.

Engine horsepower loss is approximately 3 percent for each 1000 feet (304 m) of altitude above sea level for a naturally aspirated engine. Use lower power requirement at high altitudes to prevent smoke, over-fueling and high temperatures.

NO LOAD OPERATION

Periods of no load operation should be held to a minimum. If it is necessary to keep the engine running for long periods of time when no electric output is required, best engine performance will be obtained by connecting a "dummy" electrical load. Such a load could consist of heater elements, etc.

TABLE 3.
TROUBLESHOOTING ENGINE SHUTDOWN SYSTEM
(Engines with only one fault lamp)

SYMPTOM	CORRECTIVE ACTION
1. Engine stops cranking and fault lamp lights, after cranking approximately 75 seconds.	1. See engine service manual for troubleshooting fuel system, ignition system, etc. After correcting problem, reset engine monitor relay by placing Run-Stop/ Reset-Remote switch to Stop/Reset, then back to the required running position.
2. Fault lamp lights immediately after engine starts.	2. Check for: Overspeed condition as engine starts.
3. Fault lamp lights and engine shuts down after running for a period.	3. Check the following: a. Oil level. Engine will shut down if sensor is closed. b. Check engine manual for troubleshooting oil system. c. High engine temperature. Check coolant level; check water flow (city water cooled systems); check radiator for free air flow, and fan belts for tightness. See engine manual for troubleshooting cooling system. d. Check for faulty oil pressure sensor or faulty high engine temperature sensor.
4. Engine runs, shuts down and cranks for 75 seconds. Cranking cycle stops; fault lamp lights.	4. Check fuel supply. Check ignition system.
5. Fault lamp lights, no fault exists.	5. To check a no-fault condition, disconnect leads from TB11 terminals 29, 30 and 31. If fault lamp lights with leads disconnected, replace engine monitor board. Reconnect leads.

TABLE 4.
TROUBLESHOOTING ENGINE SHUTDOWN SYSTEM
(Units with five fault lamps)

SYMPTOM	CORRECTIVE ACTION
1. Overcrank fault lamp lights and engine stops cranking after approximately 75 seconds.	1. See engine service manual for troubleshooting fuel system, ignition system, etc. After correcting fault, reset engine monitor relay by placing Run-Stop/ Reset-Remote switch to Stop/Reset position, depressing Reset button, then to the required running position.
2. Engine runs, shuts down, cranks for 75 seconds, cranking cycle stops, overcrank light ON.	2. Check fuel supply, check ignition.
3. *Low oil pressure shutdown.	3. Check — a. Oil level. Replenish if necessary. b. Sensor. Faulty sensor will shut down engine. c. Refer to engine service manual for troubleshooting guide for oil system.
4. *High engine temperature shutdown.	4. Check— a. Coolant level. Replenish if necessary. b. City water cooled sets. Check water flow, valves, etc. c. Check sensor; check thermostat. d. Radiator model, check fan belts, radiator for obstructions, etc.
5. Overspeed shutdown.	5. Check governor and throttle linkages for freedom of movement. Check overspeed switch.
6. Overspeed light on, no shutdown.	6. Disconnect wire at TB11-29. Light on after reset; replace engine monitor board.
7. *Low oil pressure light ON. No shutdown.	7. Disconnect wire at TB11-30. Light ON after relay reset. Replace engine monitor board.
8. *High engine temperature light ON. No shutdown.	8. Disconnect wire at TB11-31. Light ON after relay reset. Replace engine monitor board.

*NOTE: Not applicable on Pennsylvania State models.

OUT OF SERVICE PROTECTION

For storage of all durations, refer to the Ford engine manual

HIGH TEMPERATURES

1. See that nothing obstructs air flow to-and-from the set.
2. Keep cooling system clean.
3. Use correct SAE No. oil for temperature conditions.

LOW TEMPERATURES

1. Use correct SAE No. oil for temperature conditions. Change oil only when engine is warm.
2. Use fresh fuel. Protect against moisture condensation.
3. Keep fuel system clean and batteries in a well charged condition.
4. Partially restrict cool air flow but use care to avoid overheating.
5. Connect water jacket heater when set is not running.
6. Refer to Ford manual for further information.

BATTERY, HOT LOCATION

Batteries will self discharge very quickly when installed where the ambient temperature is consistently above 90° F (32.2° C), such as in a boiler room. To lengthen battery life, dilute the electrolyte from its normal 1.260 specific gravity reading at full charge to a 1.225 reading. The cranking power is reduced slightly when the electrolyte is so diluted, but if the temperature is above 90° F (32.2° C), this should not be noticed. The lengthened battery life will be worth the effort.

1. Fully charge the battery.
2. With the battery still on charge, draw off the electrolyte above the plates in each cell. DO NOT ATTEMPT TO POOR OFF; use a hydrometer or filler bulb and dispose of it in a safe manner. Avoid skin or clothing contact with the electrolyte.
3. Refill each cell with distilled water, to normal level.
4. Continue charging for 1 hour at a 4- to 6-amp hour rate
5. Test each cell. If the specific gravity is still above 1.225, repeat steps 2, 3 and 4 until the reading is reduced to 1.225. Usually, repeating steps twice is sufficient.

GENERAL MAINTENANCE

GENERAL

Establish and adhere to a definite schedule of maintenance inspection and servicing, application and environment being the governing factors in determining such a schedule. If your set is a prime power application, base your schedule on operating hours. Use the running time meter to log hours run; maintain an accurate record of hours and service for warranty support.

A set on stand-by duty will need servicing at times other than those recommended by Onan and the engine manufacturer. Refer to Ford manual for engine services and maintenance procedures. Adjust your schedule to satisfy the following conditions—

- Continuous duty (prime power)
- Standby power
- Extremes in ambient temperature
- Exposure to elements
- Exposure to salt water or sea air
- Exposure to dust, sand, etc.

Consult with your ONAN distributor or dealer for a schedule of maintenance and service more suitable to the unique environment and application of your set.

WARNING **Before commencing any maintenance work on the engine, generator, control panel, automatic transfer switch or associated wiring, disconnect batteries. Failure to do so could result in damage to the unit or serious personal injury in the event of inadvertent starting.**

TABLE 5. OPERATOR MAINTENANCE SCHEDULE

MAINTENANCE ITEMS	OPERATIONAL HOURS			
	10	50	200	400
Inspect Complete Set for Leaks, etc.	x1			
Check Engine Oil Level	x1			
Check Radiator Coolant Level	x1			
Check Fuel	x1			
Check Governor Oil Level* (Pierce only)		x		
Check Air Cleaner (Clean or Replace as Necessary)		x2		
Check Electrolyte Level of Battery		x6		
Stop-Solenoid Linkage, Lubricate Governor Linkage*		x2		
Change Engine Oil & Filter		x2		
Check all Hardware, Fittings, Clamps, Fasteners, etc.		x4		
Adjust Drive Belt Tension			x3	
Change Governor Oil* (Pierce only)			x	
Clean Fuel Lift Pump			x	
Clean Sediment Bowl & Filter			x	
Check Starter			x5	
Clean & Inspect Battery Charging (DC) Alternator			x	
Check AC Generator			x	
Inspect Spark Plugs, Replace if Necessary			x	
Replace Fuel Filter Element				x2
Adjust Valve Clearances				x
Inspect Ignition Points, Replace if Necessary*				x

x1 - As noted or after every run.
x2 - Perform more often in extremely dusty conditions.
x3 - Adjust to 1/2-inch (12.5 mm) depression between pulleys. Refer to Ford engine manual.
x4 - Or every 3 months.
x5 - Oil front bearing sparingly; check brushes.
x6 - Or every two weeks.
* - See Figure 34.

NOTE: The above schedule is a minimum requirement.

ENGINE

General

Basic maintenance procedures are contained within the Ford manual, which should be used in conjunction with the set manual, except in such cases where instructions state otherwise. Then, the new information unique to the EN set shall take precedence.

Air Filter

Remove wing nut in center of filter cover. See Figure 24. Remove cover and filter. Tap filter on a flat surface to remove adherent dirt. Place a light source inside the filter and inspect for free air passage. If necessary, apply a low pressure air source (30 psi [207 kPa] OSHA) to the inside of the filter to remove as much dirt as possible. Inspect interior housing. Vacuum clean if dirty, or remove housing and wipe clean.

CAUTION **Do not clean filter housing while still installed. Loose dirt entering intake could damage carburetor or engine.**

Replace air filter every 50 hours of operational time, more often in extremely dusty conditions.

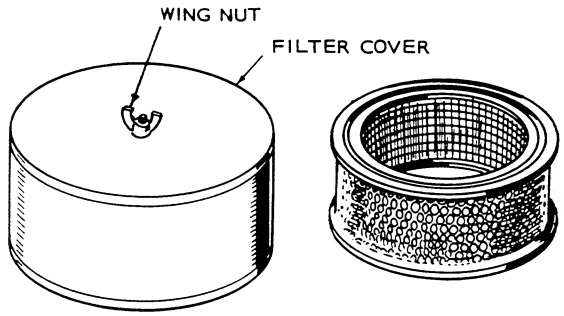


FIGURE 24. AIR CLEANER

Engine Oil Filter

Spin-off type, should be replaced with every oil change, at 50 hours of operational time.

Remove and discard old filter, wipe oil from exposed adapter recess. See Figure 25. Coat gasket of new filter with clean lubricating oil and place in position on adapter. Hand-tighten filter until gasket contacts adapter face, then advance one-half turn. DO NOT OVERTIGHTEN.

Clean all oil residues from engine, then fill crankcase. Refer to *Prestart Servicing*. Run engine and check for oil leaks; make necessary repairs. Note oil change in engine logbook.

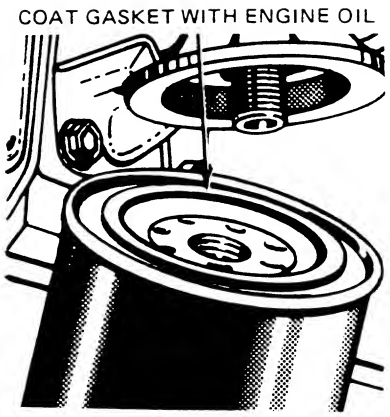


FIGURE 25. OIL FILTER ASSEMBLY

Fuel Filter

Replace filter every 200 operational hours or as conditions require. Unscrew the filter housing from the fuel pump (Figure 26) and remove the filter element and gasket. Discard the element and gasket. Clean the filter housing in a petroleum cleaning solvent.

Place a new filter element over the spout in the fuel pump valve housing cover.

Be sure to use the proper type element for the installation.

Coat a new gasket with a light engine oil and position the gasket on the filter housing. Screw the filter housing onto the fuel pump. Hand tighten the filter housing until the gasket contacts the pump, and then advance it 1/8 turn. Start the engine and check for leaks.

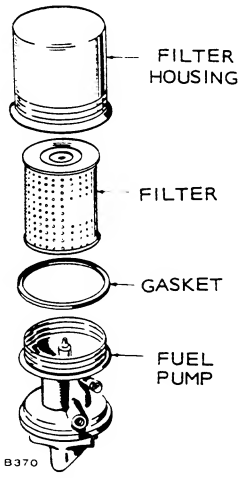


FIGURE 26. FUEL FILTER ASSEMBLY

Crankcase Ventilation (PCV) Valve

Push fit in valve rocker cover. Remove and clean at every oil change. After cleaning, shake valve to ensure ball is free, then reinstall.

CARBURETORS

The following carburetors were installed by ONAN for a specific application and engine output. Use these instructions and adjustment procedures in preference to those given in the Ford engine manual.

Carburetor, Gasoline

Carburetors have a main jet and an adjustable idle circuit. The idle needle is on the side of the carburetor. For operation at full load and no load adjustment see Figure 27.

For normal operation factory carburetor adjustments have been made to operate setting of 1-1/2 turns open which will permit starting. Adjust for best running. Allow engine to warm up before making final adjustment.

To adjust "idle" (no load) needle, see that no loads are connected to the generator. Slowly turn idle adjusting needle out until engine speed drops slightly. Turn needle in just to the point where speed returns to normal.

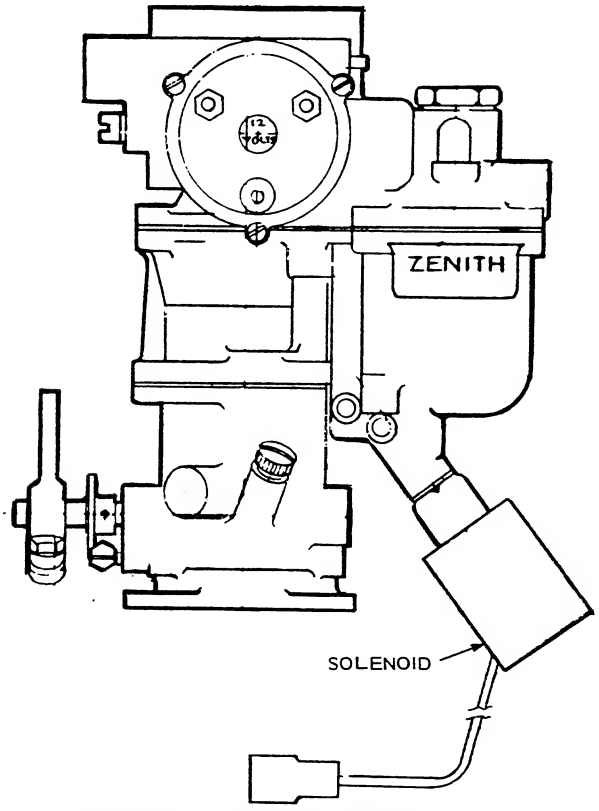


FIGURE 27. GASOLINE CARBURETOR

Combination Carburetor, Gas Operation

If the engine is equipped with a combination carburetor (Figure 28) insure the manual gasoline shutoff valve is closed and the fuel toggle switch is in the gas position. To prevent introduction of any gasoline into the intake manifold disconnect the power lead of the solenoid valve located on the gasoline carburetor. The electric choke must be adjusted so the cover is turned 10 to 12 notches counterclockwise from the "*" mark. When properly adjusted the electric choke will be completely open even at very low temperatures.

Gas fuel main jet adjustment should be made at full load only.

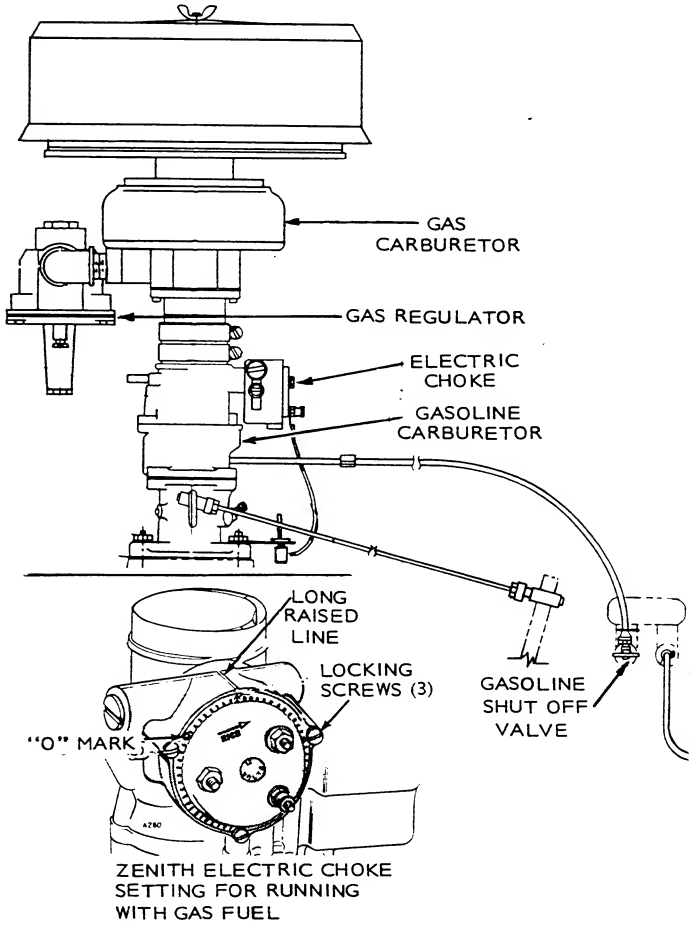


FIGURE 28. COMBINATION CARBURETOR

Carburetor, Gas

Engines equipped for natural gas operation use a gas carburetor with combined regulator. Carburetor adjustments are the same as the combination gas-gasoline carburetor. See Figures 30 and 31.

Electric Choke

A 12 volt electric choke (Figure 29) with vacuum booster is used on all engines. The adjustable choke cover is held in place by three screws. Perimeter of the cover is divided into sections by small raised marks. One mark is labeled zero and the twelfth mark from zero is labeled with an asterisk (*), which indicates normal adjustment setting. A long raised line on top of the choke housing is used as the reference mark. Normal setting for the choke is made when the asterisk mark lines up with reference line.

If overchoking occurs, loosen three locking screws and turn choke cover slightly to the left (counterclockwise). Do not turn very far. One or two notches will usually be sufficient. Tighten locking screws. To increase choking action, turn choke cover slightly to the right (clockwise). Retighten cover screws.

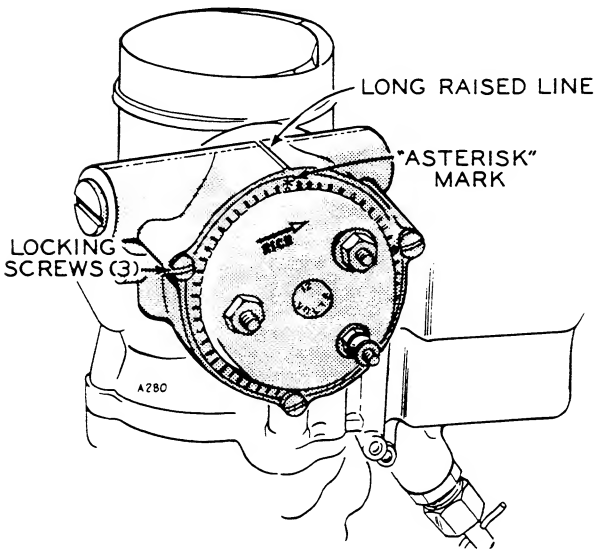


FIGURE 29. ELECTRIC CHOKE

Governor

The governor controls the speed of the engine, and therefore the frequency of the voltage. Engine speed affects AC output voltage. Use either a tachometer or frequency meter to check engine speed for proper governor adjustment. See Figure 32.

1. **Governor linkage**—With engine stopped, throttle held wide open, and tension on governor spring, adjust the governor linkage length by rotating the ball joint on the link so that the throttle stop lever clears the stop pin by not less than 1/32-inch.
2. **Warm up**—Start the engine and allow it to reach operating temperature.
3. **Speed**—With no electrical load connected, adjust the speed adjusting screw to obtain 1890 r/min (63 hertz). Apply a full electrical load. The speed drop from the no load figure should be no more than 90 r/min (3 hertz) and no less than 45 r/min (1-1/2 hertz). An incorrect speed drop from no load to full load necessitates a sensitivity adjustment.
4. **Sensitivity**—If engine tends to hunt (alternately increase and decrease speed) under load conditions, increase sensitivity screw on which the spring link pivots.

   Any change in the setting of the sensitivity screw will require correcting the speed screw adjustment. Turning the sensitivity screw clockwise causes a slight speed increase which can be corrected by turning the speed screw slightly counterclockwise to decrease spring tension.
5. **General**—Be sure that all lock nuts are tightened as adjustments are completed. Governors cannot operate properly if there is any binding, sticking, or excessive looseness in the connecting linkage or carburetor throttle assembly. A lean fuel mixture, or a cold engine may cause hunting.
6. **Output**—Check the AC output voltage.

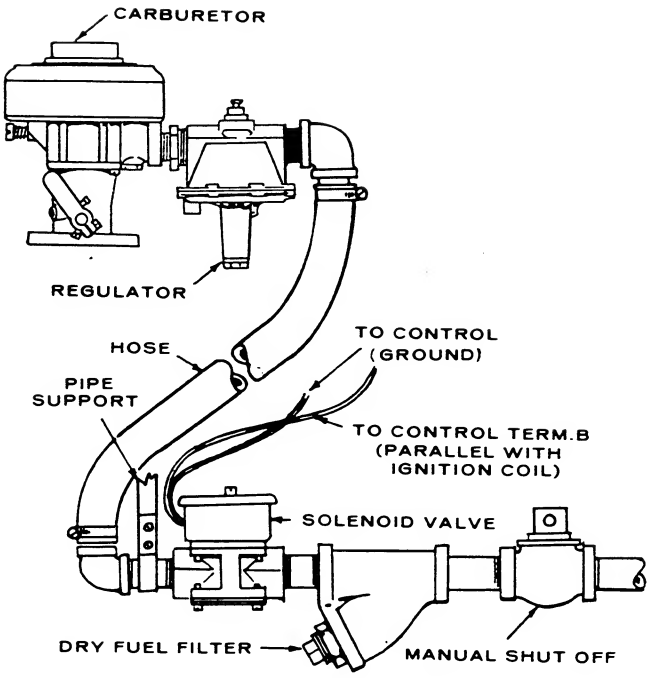


FIGURE 30. LPG VAPOR WITHDRAWAL

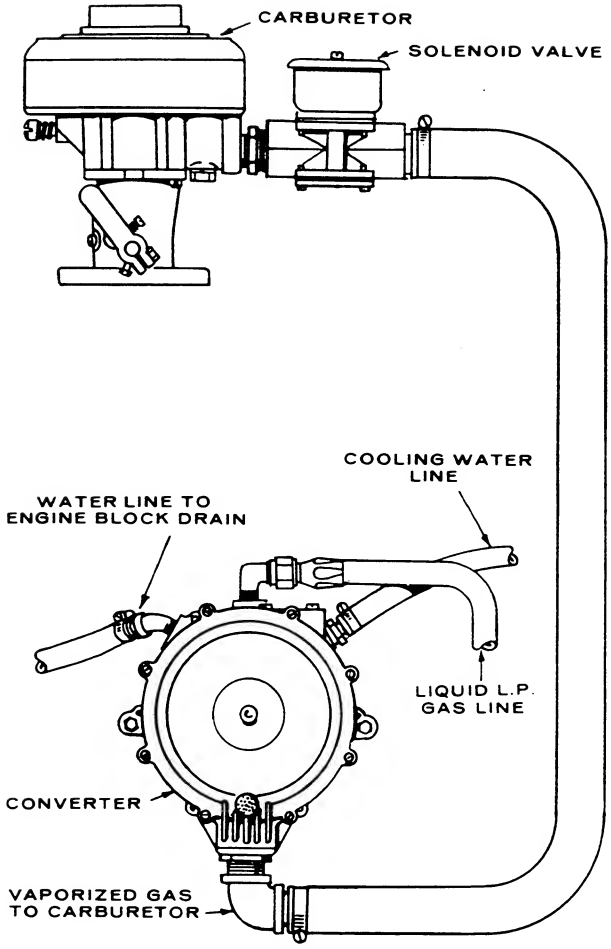


FIGURE 31. LPG LIQUID WITHDRAWAL

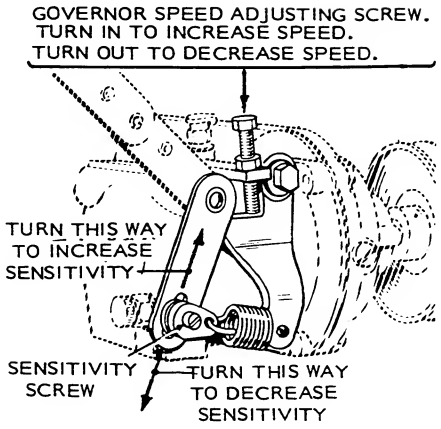


FIGURE 32. GOVERNOR ADJUSTMENT

Drive Belt Adjustment

Separate belts are used to drive fan, governor and alternator (Figure 33). Maintain correct adjustment of these belts to provide proper engine cooling and alternator output. Check belts for cracks and wear occasionally, and replace when necessary.

To adjust fan belt, loosen fan bracket screws, then move bracket up or down until a deflection of 1/2 inch (13 mm) is obtained between crankshaft pulley and fan pulley, with light thumb pressure on the belt.

To adjust alternator or governor belt, loosen link clamp screw and the mounting bolts, move alternator or governor toward or away from engine until a deflection of 1/2 inch (13 mm) is obtained between pulleys, with light thumb pressure on belt.

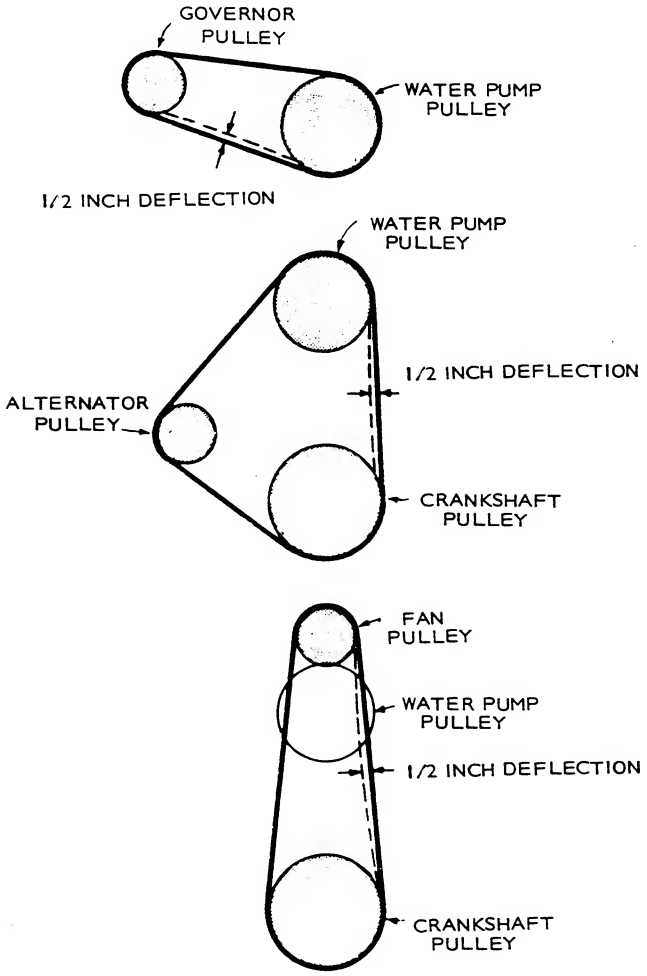


FIGURE 33. DRIVE BELT ADJUSTMENT

AC GENERATOR

There are no brushes, brush springs or collector rings on these generators, therefore they require very little servicing. Periodic inspections, coincide with engine oil changes, will ensure good performance.

Inspection

Inspect generator and control box for loose or broken wires and parts. Check diodes and printed circuit boards for excessive dust, greast or moisture. Blow these assemblies out periodically with filtered, low pressure, compressed air.

CAUTION **Excessive foreign matter on diodes and heat sinks will cause overheating and possible failure.**

Generator Bearing

Inspect the bearing for evidence of outer case rotation every 1000 hours while the unit is running.

If unit is used for "prime power," replace the bearing every 10,000 hours or two years. If the unit is used for "standby," replace the bearing every five years.

Deterioration of the bearing grease due to oxidation makes this replacement necessary.

If generator requires major repair or servicing, contact an authorized Onan dealer or distributor.

BATTERIES

Check the condition of the starting batteries at least every two weeks. See that connections are clean and tight. A light coating of grease will retard corrosion at terminals. Keep the electrolyte at the proper level above the plates by adding distilled water.

TUNE UP

ONAN suggests that the following specifications for tune up be used in preference to those given in the Ford manual. This is due to a difference in r/min (no idle speed) and removal of automatic vacuum advance.

TABLE 6. TUNE-UP SPECIFICATIONS

ADJUSTMENTS	
Spark Plug Gap	0.035 inch (0.889 mm)
Spark Plug Torque	10-15 lbs ft (13.56-20.34 N•m)
Ignition Points—Gap Setting	0.017 inch (0.431 mm)
Dwell Angle	24° - 30°
Valve Clearance Setting	Zero Lash

MAINTENANCE

Refer to Table 5 for *Operator Maintenance Schedule.*

Governor oil level should be even with bottom of the oil level plug. When adding oil to the governor, the oil should just start to flow out of the oil level plug hole. Do not overfill. See Figure 34.

Control linkage ball joint should be kept lubricated with graphite. If ball joint is neoprene, do not lubricate. Apply a light film of grease to distributor cam. See Figure 34.

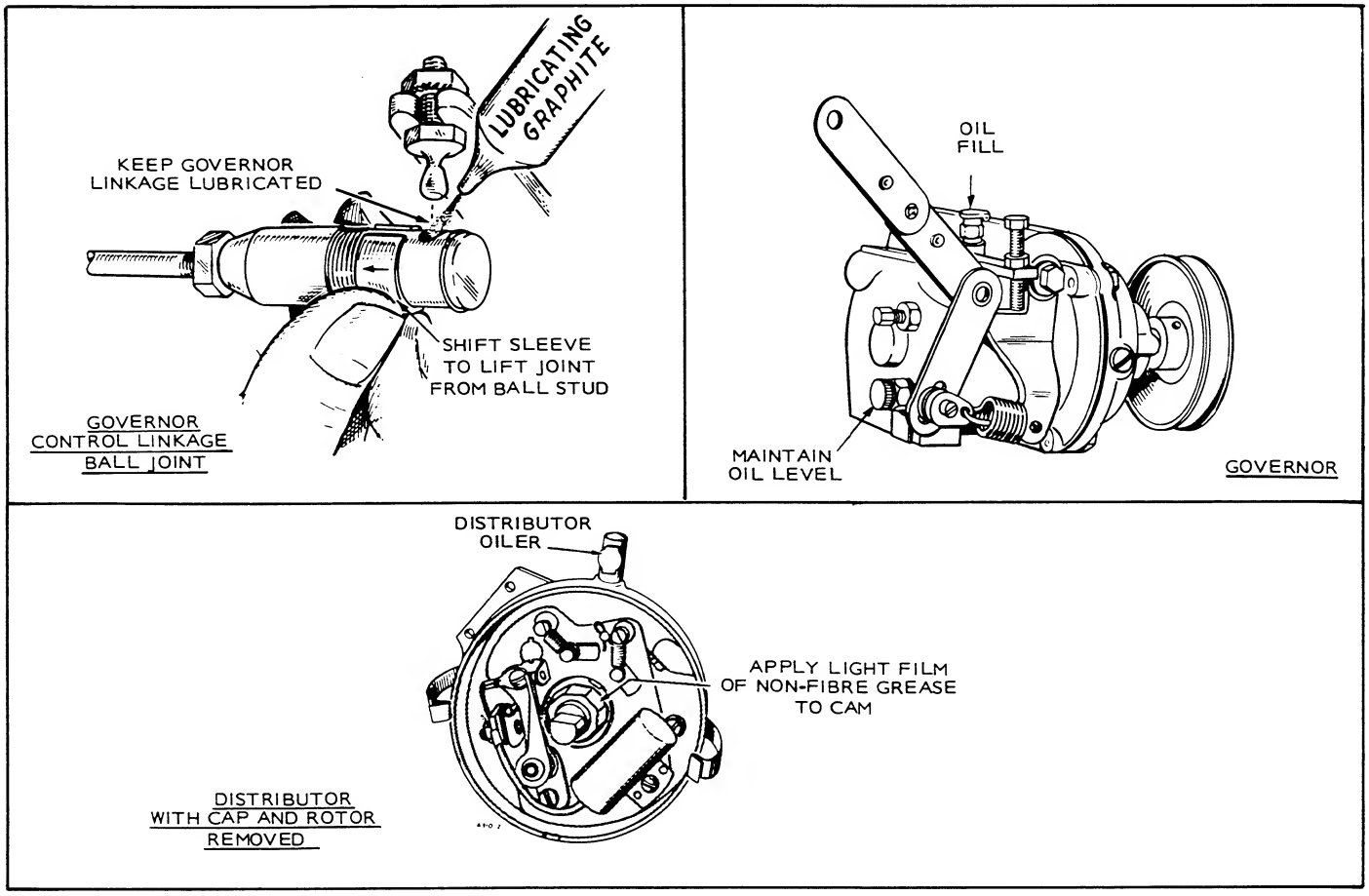


FIGURE 34. MAINTENANCE

CONNECTIONS (Fuel, Exhaust, etc.)

Operator should periodically make a complete visual inspection of the unit while running at rated load.

Some of the things to check for are as follows:

1. Check fuel and oil lines for possible leakage.
2. Inspect exhaust lines and mufflers for possible leakage and cracks.
3. Periodically or daily drain moisture from condensation traps.
4. Inspect water lines and connections for leaks and security.
5. Inspect electrical wires for security.

TANK HEATERS (Optional)

A Kim Tank Heater is optional equipment on the EN generating set. For efficient operation and optimum product life, perform the following procedure at least once a year (see Figure 35):

1. Remove head and valve assembly.
2. Clean foreign matter out of the tank.
3. Remove element and scrape off scale accumulated on the sheathing.

CAUTION **When assembling threaded aluminum parts, be sure to use anti-seize compound.**

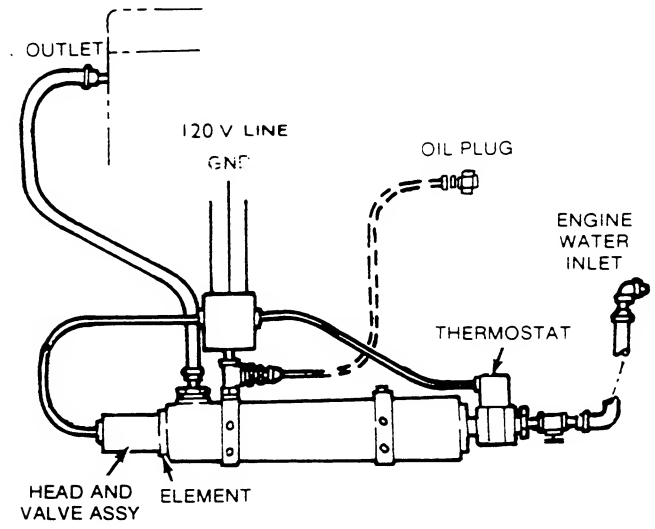


FIGURE 35. ENGINE HEATER

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